THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 54 Thursday, February 6, 1936 No. 1016

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT: 1935-36
J. E. Hurst, "Ashleigh," Trent Valley Road, Lichfield, Staffs.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham.
Sheffield: T. E. Walker, "The Priory," Oughtibridge, near Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.
London: E. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.
Newcastle-upon-Tyne: W. Scott, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.
East Midlands: B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth: J. J. McClelland, 122, Wellington Road, Bilston, Staffs.
Middlesbrough: D. Anderson, 147, Stockton Street, Middlesbrough.
Preston: P. Leyland, 6, Ashley Terrace, Farington, Lancs.
Lincoln: E. R. Walter, M.Sc., The Technical College, Lincoln.
Burnley: W. Haworth, 37, Westbourne Avenue, Burnley, Lancs.
Falkirk: H. McNair. "Braewick," Larbert Road, Bonnybridge, Scotland.

National Ironfounding Employers' Association

President: J. Smith, Smith & Company (South Shields), Limited, Nile Street, South Shields.
Secretary: Harold G. Judd, C.B.E., 8, Frederick's Place, E.C.2.

The Institute of Vitreous Enamellers

President: Dr. J. W. Mellor, F.R.S., Sandon House, Regent Street, Stoke-on-Trent.
Chairman: W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.
Hon. Secretary: Miss E. Christine Elliot, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association

President: G. T. Lunt, "Briardene," Newbridge Avenue, Wolverhampton.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President: W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretary: J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Central 1885. *Telegrams: CIRA*

The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

Contents

	PAGE
Costing and Estimating	115
Topicalities	115
Correspondence	116
Desulphurisation by Sodium Carbonate	116
The Problem of Weights	116
The Control of Cupola Operation	117
Scottish Steel Industry	118
The Dumbarton Valve Works of Babcock & Wilcox, Limited	119
An Up-to-Date Foundry Lay-out	122
High-Speed Die-Casting Machine	122
Vitreous Enamelling Section—	
Spraying Apparatus for Vitreous Enamelling	123
How Colouring Oxides are Affected by Variations of Enamel Composition	125
The Fundamental Properties of Clay	128
This Week's News in Brief	130
Trade Talk	130
Personal	130
Company Reports	130
Contracts Open	130
Forthcoming Events	130
Raw Material Markets	132

Costing and Estimating

The reception of the Report of the Costing Sub-Committee has been definitely favourable, but some critics will persist in confusing costing with estimating. The former is the operation of a system designed to adduce a definite knowledge of how money is being spent for the production of articles of commerce. It may relate to batches or classes of articles or one individual item. Estimating, inasmuch as it deals with something abstract, enters a different category. Where it relates to inquiries for goods currently manufactured, then, if a proper costing system has been in operation for some time, a knowledge of the profit can be adduced. But even in this case, a run of bad luck or improved methods of manufacture can detrimentally or beneficially influence the cost price as revealed by a systematic survey. Estimating takes cognisance of such conditions, whereas the costing system remains the same.

Such conditions arise when a foundry installs a continuous-casting plant. The costing system will not be effected, but the estimating of the costs for the ascertainment of sale prices will be materially affected. Those officers responsible will have to take into consideration the likelihood of increased or decreased production of scrap, and those border-line cases as to whether a casting is suited, by reason of much coreing, to be made on the plant. These are questions entirely different from costing. Estimating is logical guesswork, costing the ascertainment of data as near to the truth as human intelligence can make them. There has been, and always will be, a number of persons who regard a detailed costing system as being likely to enhance overheads by the introduction of extra clerical labour. Yet, from personal observation, they are the very people for whom the system is simplest, because in general they control small works with few departments, and subdivision is not of such great importance so long as they are satisfied that each job they make carries its fair share of overheads and makes a profit. It is commercially unethical to sell a single casting which does not contribute its quota to the profit account. Estimating by costing-system sneerers is the worst form of guesswork, as it is devoid of a factual background.

Topicalities

We drew attention a few months ago to some discoveries in China which went to show that the art of casting metals was known and practised there centuries before the earliest known development elsewhere. This, of course, is quite in keeping with the Chinese way of casually inventing things and not making a song about them, such as porcelain in the third century, and gunpowder and taxi-carriages in the fourth. Paper money and printing were two more of their early ideas. This week a report comes of the discovery in the Shensi province of a mould for making coins at least two thousand years old. The mould was revealed during the digging of a railway bed, and near it was a mould for casting bronze mirrors of a dynasty dating back to about 200 B.C. to A.D. 200. The exhibition of Chinese art at Burlington House gives some idea of the extraordinary wealth of that country as far as artistic resources go. A visit to it can be strongly recommended.

* * *

Some of the remarks made in the report of a committee on legal procedure, and recently published, will be of interest to our readers. Some attempt has been made to prevent appeals against verdicts in patent actions, and this committee says that these actions are often remarkable for their length and complexity. They are, however, of such financial and commercial importance that no limitation of or restriction on rights of appeal is recommended. In order to crystallise the issues, however, the committee recommends that the judge be empowered to direct that the parties should exchange, before trial, a complete statement of the matters of fact and contentions of law. The committee also recommends an investigation into the practice of putting patents on file to discourage competition and thereby facilitating competitors being threatened with patent actions. It is contended that there are many patents put on file that would never be granted if objection could be taken to them on ground of lack of subject matter. We may be permitted to heave a sigh of relief that appreciation of this point has now reached legal circles.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Costing Report

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—After carefully reading the reports of the Sub-Costing Committee, as given in the issues of THE FOUNDRY TRADE JOURNALS of January 23 and 30, I feel that I should like to express my views to your readers. Some very interesting points had apparently arisen and had been very well settled, but the same old question of value of home scrap again brought forward the several different opinions.

It does not appear to be such a hard problem to the "cost-man" as it seems to be to the "foundryman," but every man to his trade.

To express my opinion, one which has, I believe, many supporters, I will commence with some fictitious figures and, for the sake of clarity, I will use an extreme as regards scrap remaining; I will use 30 per cent. (some I know give 50 per cent.). For easy calculation purchased scrap is omitted.

Example:

		£	s.	d.
Mixture	5 tons pig at £4 per ton	20	0	0
	5 tons scrap at £2 10s. ,,	12	10	0
	10	£32	10	0

Scrap is in at market price in this instance.

Castings produced ...	6½ tons
Scrap	3 ,,
Loss in melting ...	½ ton
	10 tons.

(A) Using the "mixture-cost" method for valuing home scrap, the £32 10s. would be accounted for as:—

	£	s.	d.
Scrap to stock 3 tons at £3 5s. ...	9	15	0
Cost of casting 6½ tons	22	15	0

Cost of casting per ton = £3 10s.

Melting charges are purposely omitted.

(B) Using the "market-value" method of pricing home scrap back to stock we get:—

	£	s.	d.
Scrap to stock 3 tons at £2 10s....	7	10	0
Cost of casting 6½ tons	25	0	0

Cost of casting per ton = £3 17s. approx.

Before making the remark "my costs are lower by the first method" please consider: By the mixture-cost method the price of the scrap will be continually increasing until it *almost* reaches the value of the pig-iron.

Only little consideration is necessary to find that the cost per ton of castings will continually increase at each melt in sympathy with the increased prices of home scrap. Also the financial accounts will show inflated values of stocks and thereby result in fictitious profits. It is much better to be on the safe side, which one will be if one uses market value of scrap. Inflated stock values will not be shown.

At one point I see it is mentioned that "value is not the point to be considered, but rather the cost." How can you arrive at the cost of the next mixture if you do not know the value of the last scrap?

At the same time it is stated by cost and other accountants that stocks should be valued at market price *or* cost *whichever is the lower.*

Mr. R. A. Jones' suggestion is sound, and complies partly with the foregoing remark on market price or cost.

Then Mr. Hodson said that it had cost something to produce the scrap and that that was what the foundrymen should be concerned with. From a cost-man's point of view, however, it would appear that the cost had been incurred by the castings required and not by the scrap (because we had not tried to produce scrap, but castings and profit), and that the scrap returned was some residue from the original prime cost for which some allowance could be made. That is why the melting charges should be absorbed on castings produced, and not on all metal from spout.

One point which seems to have been overlooked is that no matter what price home scrap is debited at to stock, at that same price (or average on these prices) must the credits be made. What is saved in one casting means a higher charge in subsequent castings. Here I will put a question: What price are you allowing for scrap in your estimates?

Apart from this point I feel that some congratulations are due to the Sub-Committee for the principles they have outlined, and I express that opinion as an "outsider."—Yours, etc.,

"AD VALOREM."

Moisture in Loam

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have been observing the wide variation in the moisture content of loams received on the North-East Coast from the Thames estuary. This ranges from 8 per cent. in summer to 24 per cent. in winter. It appears to me to be very uneconomic to have to pay on a tonnage which comprises such a large volume of water. It has been suggested to the suppliers of loam that they should be paid *pro rata* by the operation of a sliding scale on the moisture content.

It may be a feasible proposition for the loam suppliers to instal a drying plant at the quarries, the cost could be met by a slight increase on the tonnage rate, which the foundryman would not object to pay with the assurance that he was receiving a consistent reasonably dry loam. It would be interesting to have the views of foundrymen on this subject.—Yours, etc.,

F. BLAKISTON.
"Roslyn,"
Acklam Road, South,
Middlesbrough.

January 27, 1936.

Desulphurisation by Sodium Carbonate

The Imperial Chemical Industries, Limited, have issued a very artistic booklet which is a photographic record of an engineering feat of much interest, and in which the sodium-carbonate process played an important part. The use of sodium carbonate as a refining flux is now standard practice in the manufacture of high-grade engineering castings in iron, and its value was very strikingly demonstrated in the successful carrying out this year of a contract for a 10,000-cub. ft. compressor, placed with the firm of Messrs. Walker Bros. (Wigan), Limited, by the Anglo-American Mining Corporation of South Africa. One cylinder casting alone weighed 20 tons, and since the mould for this took nearly three months to prepare, no risk could afford to be taken in a job in which, nevertheless, time was important. Actually, the pouring of this gigantic cylinder casting was carried out without a hitch in approximately 60 sec. Other castings for the compressor included those for a 20-ft. dia. flywheel and numerous smaller and more intricate castings, all demanding perfectly clean degasified metal. Out of the 250 tons of castings involved, there were less than 5 cwts. of "wasters," and the photographs give a remarkably clear idea of the clean appearance of the skin of the castings, and of the very fine machined surfaces which it was possible to obtain.

MESSRS. WILLIAM PICKERSGILL & SONS, LIMITED, Sunderland, have booked orders for three colliers—one for Messrs. France, Fenwick & Company, London, and two for Messrs. Stephenson Clarke & Associated Companies, Limited, London. All three vessels will be engined by the North Eastern Marine Engineering Works, Sunderland.

The Problem of Weights

BY "ONLOOKER."

With stocktaking out of the way, at least as far as the actual weighing is concerned, manufacturers can once again turn their thoughts to developing their trading programme for the New Year, but before doing so it may be worth while having a look at the actual total of the metal stock compared with the theoretical figures. Absolute agreement is, of course, extremely unlikely and would, in fact, be regarded as achieved more by luck than judgment, but, provided that proper allowance has been made for loss, there should not be very much discrepancy in the two sets of figures. It is, of course, taken for granted that scales are kept in a condition as nearly perfect as possible, regularly overhauled, and controlled by operatives who have thoroughly mastered their job. It is true that copper, lead and spelter are not priced very high to-day, but tin, nickel and aluminium are relatively valuable, and taking the non-ferrous group all in all, it is obvious that faulty weighing over a twelvemonth must result in losses that may well be serious to the business concerned. Small leaks continuing year after year may make just the difference between the success and failure of a trading venture however well conducted it may be in other directions.

Scrap gives perhaps as much trouble as anything in the weight question, for the nature of old metal is such as to make for difficulties and disputes. Parcels often change hands several times before reaching their destination in the foundry, and, somehow or other, the weight seems to suffer in the process, nor is it easy to discover just where the trouble arose in the first place. Then there is the question of tare, either bags or casks, of parcels which are delivered in containers, and let us not forget that bags will increase in weight quite considerably if left out in a rainstorm. Quite often the supplier has estimated the tare, or perhaps passed on the weight submitted to him, and one way and another variations seem to occur, if only because bagged material which has gone the rounds is frequently contained in double bags and tared on the basis of single! One last word in a general sense. Weather *does* upset scales, and wherever possible weighing should be carried out under adequate shelter from rain and snow.

Virgin Metal Position

On the whole, the non-ferrous industry does not experience much trouble with its supplies of virgin metal, for the refineries overseas have installed up-to-date units for weighing before shipment, and a manufacturer buying to-day on the basis of refinery or shipping weights need not fear serious discrepancies. In fact, having checked the count in the parcel he can rest reasonably assured that weighing will not reveal anything wrong. However, it is undoubtedly a sound rule to put all incoming raw material over the scales, if only to make employees "weight minded," to use the trite jargon of the publicists, and so to ensure that the utmost vigilance is maintained in all departments of the factory, for errors in the weights of material transferred internally between departments will upset manufacturing costs and lead to trouble. Equally important is the question of the weight of outgoing material, for inaccuracy here must be a drain on the profits, or, alternatively, there is trouble with a customer, for people are very touchy about being charged up with what they have not received! Disputes over weights can lead to a lot of unpleasantness, and before now serious misunderstanding and bad feeling have been engendered on the sales side through quite a trivial difference of opinion about the actual avoirdupois of a delivery. All very well to give way gracefully in the end, but should your client be thin skinned (and clients usually are!), his faith may well have been shaken and relations strained in consequence.

The Control of Cupola Operation*

By H. L. CAMPBELL and JOHN GRENNAN

The cupola furnace is the most widely used melting unit for cast iron, and the best results from its operation can be obtained only when all divisions of the practice are under definite control. In the following Paper, attention is given to the combustion conditions within the cupola and to the proportioning of the metal, fuel, flux, and air supply. A definite amount of air may be supplied to the cupola, containing sufficient oxygen to burn a definite weight of coke, which in turn will produce sufficient heat to melt and superheat a definite weight of metal. Furthermore, a definite weight of flux is necessary to obtain satisfactory slagging conditions. When the correct proportions of air, fuel, flux and metal are used, reliable and uniform melting conditions are obtained in the cupola.

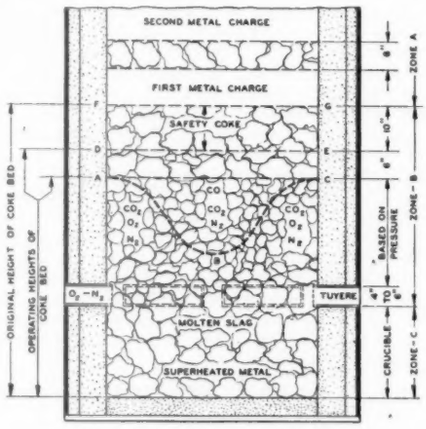


FIG. 1.—CROSS-SECTION OF CUPOLA.

The entire shaft of the cupola may be divided into four sections for convenience in examining the operation of this furnace. The upper part of the cupola from the sill of the charging door to the top of the shell is known as the stack. This section serves only for the removal of waste heat and gases from the cupola. Zone A extends from the charging door to the top of the coke bed. Within this volume the coke and metal charges are preheated by the ascending gases. On account of the deficiency of oxygen in the gases in zone A practically no combustion of the coke takes place in this section. The heat in this region is sufficient to dissociate the limestone flux into lime and carbon dioxide, and to melt some thin pieces of scrap metals. Near the bottom of zone A the temperature of the gases is about 1,650 deg. C., and the temperature decreases as the gases travel up through the charges. At the level just below the charging door temperatures of 425 to 815 deg. C. have been obtained. The bottom of the tuyeres locates the lower level of zone B, as shown in Fig. 1. Maximum combustion of the fuel takes place within this section. Furthermore, the charges are so arranged that most of the melting and superheating of the metal occurs in the upper part of zone B. The lower portion of the interior of the cupola from the bottom of the tuyeres to the sand bottom is the crucible. Molten metal and slag collect between the pieces of coke within this volume. Since practically no combustion takes place below the tuyeres, it is impossible to add heat to the metal which is retained in the crucible.

* A Paper presented to the Shop Operating Courses at the Toronto Convention of the American Foundrymen's Association. The Authors are respectively Associate Professor of Metal Processing and Instructor in Foundry, College of Engineering, University of Michigan, Ann Arbor, Michigan.

Combustion Conditions in the Cupola

When the cupola is in operation, air is delivered at a relatively low pressure into a bed of hot coke in the lower part of the cupola. Additional fuel is supplied in the coke charges to preheat, melt, and superheat the succeeding metal charges. Combustion is maintained by the chemical reactions which take place when carbon and oxygen are brought together at relatively high temperatures. The conditions for supporting combustion are not ideal, because the materials used for this purpose are not in the pure elementary form. Foundry coke usually contains over 5 per cent. of weight of ash, which must be removed after the coke has been burned, and the nitrogen content of the air is about 76.9 per cent. by weight. The intensity of the heat developed by the oxidation of the carbon in the coke is decreased by the nitrogen in the air supply. However, the heat efficiency of the cupola is high compared with other melting furnaces, because the products from the combustion of the fuel come in direct contact with the materials being melted, and the counter flow of gases and melting stock permit the recovery of much of the heat produced within the cupola.

At the high temperatures encountered in the bed of a cupola furnace, the oxygen in the air supply combines with the carbon in the coke to form carbon dioxide. The chemical reaction for the complete combustion of carbon is as follows:

$$C + O_2 = CO_2 + \text{heat.} \qquad (1)$$

This equation implies that 12 lbs. of carbon will combine with 32 lbs. of oxygen to produce only carbon dioxide with an evolution of heat. The complete combustion of 1 lb. of carbon requires 2.66 lbs. of oxygen, and develops 14,550 B.T.U. of heat.

Another chemical reaction which occurs to some extent in normal cupola operation is indicated by the following equation:—

$$CO_2 + C = 2CO - \text{heat.} \qquad (2)$$

This secondary reaction takes place when the carbon dioxide which was formed by complete combustion comes in contact with more carbon at high temperatures. For every pound of carbon consumed in this way, 5,850 B.T.U. of heat are absorbed from the reacting materials. Hence, the conditions which favour this reaction are avoided as much as possible in cupola practice.

When the cupola blower is operating, the air which enters the tuyeres encounters the hot coke in the bed, and soon becomes heated. Combustion of the coke proceeds more rapidly as the air passes up through the coke in the bed. If the bed be of sufficient height, a location is reached at which the oxygen in the air is completely consumed by combustion to carbon dioxide according to reaction (1). As the carbon dioxide thus formed continues to travel past more hot coke, some carbon monoxide is produced according to reaction (2). If the height of the coke bed and the rate of the air supply be properly adjusted, this heat-consuming reaction proceeds only to a minimum extent.

In Table I the conditions resulting from the combustion of carbon are arranged in eleven groups, based on the proportions of carbon dioxide (CO_2) and carbon monoxide (CO) finally produced from the combustion reactions. The analyses of the gases associated with the different combustion conditions as given in Table I were found by transposing the weights of the products to proportions by volume. With condition A all the carbon is burned to carbon dioxide, and according to the reaction for complete combustion, 2.66 lbs. of oxygen are required to burn 1 lb. of carbon. This weight of oxygen (O_2) is equivalent to 11.5 lbs. of air or 151 cub. ft. of air at 15 deg. C. and 14.7 lbs. per sq. in. If the coke contains 90 per cent. carbon, 136 cub. ft. of air will be necessary to burn 1 lb. of coke. With condition K all the carbon is finally burned to carbon monoxide and one-half as much air is needed as is required for combustion condition A. With condition F equal amounts of carbon are finally burned to carbon dioxide and carbon monoxide, and the reactions require 2.00 lbs. of oxygen [(2.66×0.50) + (1.33 × 0.50)]; this is equivalent to 102 cub. ft. of air for every pound of coke containing 90 per cent. carbon.

The combustion condition within any cupola can be established by the analysis of the cupola gases. With good cupola practice the proportions by volume of carbon dioxide and carbon monoxide in the gases just below the charging door will be about equal. The gas samples from cupolas operating under favourable conditions will contain about 14 per cent. carbon dioxide, 12 per cent. carbon monoxide, and 74 per cent. nitrogen. The carbon monoxide content of cupola gases is seldom greater than 20 per cent. by volume. On the other hand, the analyses of cupola gases seldom show less than 7 per cent. by volume of carbon monoxide, unless auxiliary air is introduced above the coke bed.

Melting Ratio

The total heat produced from the complete combustion of 1 lb. of carbon is 14,550 B.T.U., or of 1 lb. of coke containing 90 per cent. carbon is 13,095 B.T.U. (14,550 × 0.90). If the conditions are such that only carbon monoxide is produced from the combustion reactions, the total heat developed from each pound of coke will be 3,915 B.T.U. [(14,550 − 5,850) ÷ 2 × 0.90.] The amounts of heat produced from 1 lb. of coke for other combustion conditions are given in Table II. Under combustion condition F, 75 per cent. of each pound of carbon is burned initially to carbon dioxide with the development of 10,912.5 B.T.U. of heat

TABLE I.—*Air required for different Combustion Conditions.*

Combustion Condition	Per Cent Weight of Carbon Burned: Initially CO_2	Per Cent Weight of Carbon Burned: Finally CO_2	Per Cent Weight of Carbon Burned: Finally CO	Gas Analysis, Per Cent Volume of Gases: CO_2	Gas Analysis, Per Cent Volume of Gases: CO	Gas Analysis, Per Cent Volume of Gases: N_2	Lb. O_2 per Lb. Coke	Lb. Air per Lb. Coke	Cu. Ft. Air 60 Deg.—14.7 Lb. per Lb. Coke	Cu. Ft. Air 60 Deg.—14.7 Lb. per Lb. Coke (90 Per Cent C.)
A	100	100	0	21.0	0	79.0	2.66	11.5	151	136
B	95	90	10	19.7	2.1	78.2	2.53	10.9	143	129
C	90	80	20	18.3	4.5	77.2	2.39	10.4	136	123
D	85	70	30	16.6	7.1	76.3	2.26	9.8	128	115
E	80	60	40	15.0	9.9	75.1	2.13	9.2	121	109
F	75	50	50	13.0	13.0	74.0	2.00	8.7	113	102
G	70	40	60	10.9	16.6	72.5	1.86	8.1	106	95
H	65	30	70	8.7	20.3	71.0	1.73	7.5	98	88
I	60	20	80	6.1	24.6	69.3	1.60	6.9	91	82
J	55	10	90	3.2	29.4	67.4	1.46	6.3	83	75
K	50	0	100	0	34.7	65.3	1.33	5.8	76	68

(14,550 × 0.75), and the remaining 25 per cent. reacts with the carbon-dioxide gas to produce carbon monoxide with 1,462.5 B.T.U. of heat (5,850 × 0.25) absorbed as a result of this reaction. Therefore, the net amount of heat available from 1 lb. of carbon when burned under combustion condition F is 9,450 B.T.U. (10,912.5 − 1,462.5) and from 1 lb. of coke is 8,505 B.T.U. (9,450 × 0.90).

The amount of heat required to melt 1 lb. of cast iron and to superheat this metal to any desired pouring temperature is given in Fig. 2. When the iron is tapped from the cupola at 1,400 deg. C., 460 B.T.U. of heat will be necessary for each pound of metal.

To determine the number of pounds of cast iron which can be melted with 1 lb. of coke in the cupola, it is necessary to establish the proportion of the total heat which is used for preheating, melting and superheating the metal. Other uses of heat in the cupola include heating the gases and the coke in addition to the preheating and dissociation of the limestone. Attempts have been made to determine the heat balance for the cupola furnace, and the results have shown that about 50 per cent. of the actual heat produced from the combustion of the coke is used in heating and melting the metal charges.[1] As 8,505 B.T.U. are produced from 1 lb. of coke under combustion condition F, 9 lbs. of metal can be melted and superheated to 1,400 deg. C. with 50 per cent. of the total heat produced from the coke [(8,505×0.50)÷460].

TABLE II.—*Metal to Coke Ratios for Different Combustion Conditions.*

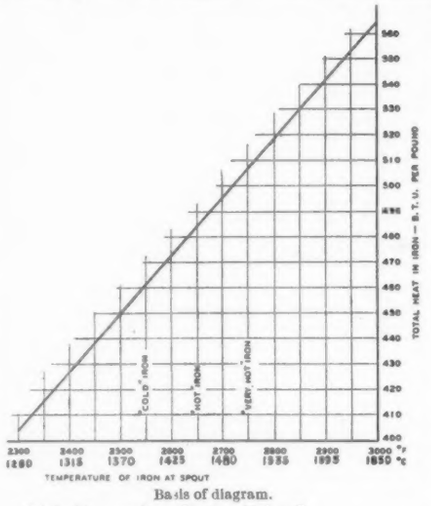
Combustion condition.	Heat produced per lb. of coke (90 per cent. C) B.T.U.	Lb. iron melted per lb. of coke and superheated to		
		1,230 deg. C.	1,455 deg. C.	1,510 deg. C.
A	13,095	14	14	13
B	12,087	13	12	12
C	11,259	12	12	11
D	10,341	11	11	10
E	9,423	10	10	9
F	8,505	9	9	8
G	7,587	8	8	7
H	6,669	7	7	7
I	5,751	6	6	6
J	4,833	5	5	5
K	3,915	4	4	4

When a greater heat efficiency is obtained or a larger amount of heat is produced as a result of more favourable combustion conditions, the ratio of pounds of metal melted per pound of coke will be increased. The heat produced from 1 lb. of coke and the number of pounds of metal which can be melted and superheated to each of three different temperatures under the specified combustion conditions are given in Table II. When steel scrap is used in the metal charges for the cupola, some carbon is absorbed by the steel, and the number of pounds of metal melted for each pound of coke will necessarily be less than is possible when only pig-iron and iron scrap are used in the cupola charges.

The Height of the Coke Bed

The coke bed is made sufficiently high so that all melting of the metal charges will be confined to that portion of the cupola in which there is no free oxygen. The production of iron of good quality by this method of melting depends to a large extent upon maintaining the correct height of the coke bed throughout the entire heat. When the bed is too low, the oxygen in the air supply will not be completely consumed by the coke in the bed, and will pass up through the metal charges causing the rapid oxidation of the metal. If the coke bed be higher than is necessary for the complete consumption of the oxygen, the carbon dioxide formed initially will combine with more carbon in the upper part of the bed to produce carbon monoxide. This reaction will prevent the development of the maximum amount of heat from the coke in the top portion of the bed and will retard the melting.

An extensive investigation of the conditions of combustion within a cupola furnace was made in 1913 by A. W. Belden, of the U.S. Bureau of Mines.[2] The compositions and temperatures of the gases were found at many points within the coke bed of a cupola. From the results of these determinations, the area which located the highest temperatures in the fuel bed was found to have the shape of an inverted cone, with the base intersecting the cupola lining 20 in. above the top of the tuyeres, when the air was supplied at a pressure of 5.3 ozs. per sq. in. The line *A-B-C* in Fig. 1 locates the cross-section of the area of highest temperature in the coke bed. Below this area free oxygen is present in the gases. In order to melt the metal charges without excessive oxidation, all melting must be completed above the level in which oxygen is present in the fuel bed of the cupola. The exact location of this area, which is represented by the straight line *A-C* in Fig. 1, is dependent upon the volume of the air supplied to the cupola.



Basis of diagram.
Original temperature of iron = 15 deg. C.
Gross melts at 1230 deg. C.
Specific heat of solid iron (15 to 1230 deg. C.) = 0.288 B.T.U. per lb. per deg. C.
Latent heat of fusion = 41.5 B.T.U. per lb.
Specific heat of liquid = 0.41 B.T.U. per lb. per deg. C.

FIG. 2.—TOTAL HEAT IN IRON AT CUPOLA SPOUT.

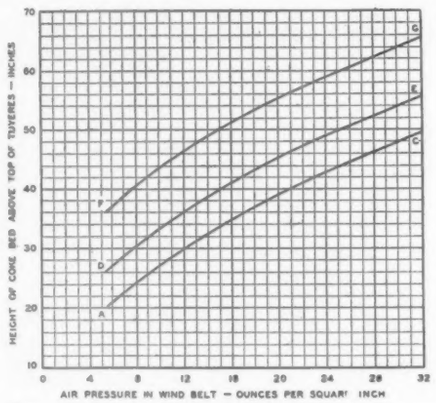


FIG. 3.—HEIGHTS OF COKE BED FOR DIFFERENT AIR PRESSURES.

The investigations which have been made of the conditions of combustion within the fuel bed of the cupola furnace have shown that the oxygen in the air supply is gradually consumed as it passes through the hot coke bed. A certain amount of time is required for the oxygen to combine with the carbon, and the distance that the oxygen travels before it is completely burned to carbon dioxide depends upon the velocity of the gases. This in turn is controlled by the volume of air delivered to the cupola. An increase in the volume of the air supply causes an increase in the pressure in the wind belt, with other conditions constant. Since the air pressure can be readily measured, the location of the region of minimum oxygen in the coke bed can be established most conveniently on this basis. The line *A-C* in Fig. 3 indicates the minimum operating heights of the coke bed for all pressures in a cupola of any size. The points on the line *A-C* were computed on the basis of the increase in the velocity of the gases over that used by Belden to obtain a height of 20 in. above the top of the tuyeres for the location of minimum oxygen. It is important that all melting of the metal charges be confined above the line *A-C* in Fig. 3, where practically no oxygen is present in the gases. The line *D-E* locates the top of the 6-in. layer of coke which will replace the coke consumed in the development of heat for melting and superheating the first metal charge. To compensate for the settling of the bed, as well as for the consumption of fuel from the time the coke bed is measured until the blower is started, the bed is increased by an additional height of 10 in.; this is known as safety coke. Under normal operating conditions, the height of the coke bed varies between points on the line *D-E* and points on the line *A-C* corresponding with the operating air pressure in the wind belt. The coke between these limits is replaced intermittently by the succeeding coke charges.

(To be concluded.)

1 J. E. Hurst, "Melting Iron in the Cupola." Penton Publishing Company. 1929. Refer to pp. 111-118.

2 A. W. Belden, "Foundry-Cupola Gases and Temperatures." U.S. Bureau of Mines Bulletin 54, 1913.

Scottish Steel Industry

FURTHER GROUPING OF INTERESTS

Messrs. Colvilles, Limited, who acquired, on the formation of the company, the steelworks of David Colville & Sons, Limited, and James Dunlop & Company, Limited, have now acquired practically the whole share capital of the Steel Company of Scotland, Limited, from the shareholders of that company. The present board of the Steel Company of Scotland, of which Sir James Lithgow is chairman, will remain in office.

Colvilles, Limited, have also acquired from David Colville & Sons, Limited, the whole ordinary share capital of Smith & McLean, Limited, and the whole issued share capital of the Clyde Alloy Steel Company, Limited, Fullwood Foundry Company, Limited, and the Carnlough Lime Company, Limited. In all cases, the purchase price is being satisfied by the allotment of ordinary shares of Colvilles, Limited, credited as fully paid.

Unification of the steelmaking interest of the West of Scotland is thus brought a step nearer. The two Scottish companies have many things in common, but in some respects they will be increasing one another's range. Colvilles have blast furnaces and pig-iron supplies, which the Steel Company does not possess. Through their subsidiary, Smith & McLean, Colvilles offer a range of sheet production from ¼ in. to 32 gauge, and in the Clyde Alloy Steel Company they have a source of supply of special steels (particularly for motor-car transmission and other specialised trades), which help both concerns.

Cellophane-Covered Pipes

MR. WALTER F. ROGERS, in the course of a letter to the editor of "Metals and Alloys," states that he has just completed an underground test using cellophane as a wrapping material for pipe lines. The test lasted four years and four months. Celluloid was also used and was found to be superior to cellophane.

The Dumbarton Valve Works of Babcock & Wilcox, Limited

A HIGHLY-SPECIALISED INDUSTRY

The building of valves might well be regarded as the natural development of a concern who are exceptionally large consumers of valves in connection with their staple production, and who have been responsible for so many important innovations in steam-generator design and boiler-house auxiliaries and equipment.

In steam generator design the most revolutionary departure, since the advent of the tubular boiler, was unquestionably the high-pressure boiler, which was introduced by Babcock & Wilcox so far back as 1917. At that date there is no doubt boilers for working pressures of 800 lbs. and over were more or less regarded in the nature of a doubtful experiment. However, needless to say, the design had been very thoroughly tried out at the works of the originators before being offered to the public. Successful from the very outset, such boilers may now well be regarded as standard.

The manufacture of boilers for such abnormally high pressures naturally introduced an entirely new set of factors, calling for the installation of special machines and plant as also for the evolution of a new range of boiler fittings, more particularly valves. It certainly would not have been possible to build up valves designed for medium pressures and temperatures to meet in a satisfactory manner the higher working pressures and temperatures. To meet the new conditions radical departures had to be made alike in design, material and constructive methods.

Although Babcock & Wilcox were manufacturing valves for low-pressure duties so far back as 1920, it was not until some five years later that they gave serious consideration to the building of valves to meet high-pressure requirements. We use the term building advisedly, because valves for such duties, if they are to have initial and maintained efficiency must be constructed with the same degree of precision as the highest class of machine tool. Recognising that valve building is a highly specialised industry, it was determined to lay down a works equipped to meet the particular requirements.

The company had available at Dumbarton a site with a total area of 31 acres; of this area a portion was laid off for the production of seamless tubes. The site is on the north bank of the River Clyde, about 14 miles west of Glasgow, the main road to which city runs along the north side of the works, whilst the L.M.S. Railway bounds the works on the south side. The works are thus very well placed in regard to transport facilities; but further, they lie within about 11 miles of the company's works at Renfrew which simplifies the closest co-operation between the valve factory and the boiler business, a co-operation which makes for both efficiency and economy.

Thus the whole of the requirements of the Renfrew works for high-class non-ferrous castings are met by the Dumbarton Foundry, production being carried on under conditions which would scarcely exist in the non-ferrous foundry of the boiler works. At the same time high-class steel and iron castings are essential to a boiler works, and Renfrew efficiently meets the demands of the Dumbarton works for these. The calorising process which was initially introduced for soot-blower elements has been found of great advantage for treating baffle parts and other material in water-tube boilers which are exposed to the hot products of combustion and such parts are now calorised at Dumbarton for inclusion in deliveries from Renfrew. The X-ray equipment installed at Renfrew for Babcock Class One fusion welding is made frequent use of by the Dumbarton works not only for the exploration of welded work but also for the investigation of valve bodies in the form of castings of new design, whilst the assistance of the large welding staff at Renfrew is available for Dumbarton. Finally, there is the centralisation of the chemical and metallurgical laboratories at Renfrew where routine analyses, tests of alloys, and routine mechanical tests of parts from Dumbarton are made in conjunction with similar tests necessary on work in progress at Renfrew.

The Dumbarton works comprise four main blocks of buildings, *i.e.*, the main offices and the administrative building, which include the finished-valve store, packing and shipping departments, the calorising department, the valve factory and the tube mill. The purpose of the present article is to describe the valve factory, although the output is not solely valves, sections of the shops being devoted to the manufacture of soot blowers, oil-burner apparatus, tube expanders, tube cutters and similar accessories. At the same time, the first consideration in the lay-out of the works was the production of valves of the highest class, and valves from ¼-in. to 16-in. bore for pressures from 10 lbs. per sq. in. to over 2,000 lbs. per sq. in. have been built and tested.

Correct design is, of course, essential to success, and a special valve-design department is incorporated in the Dumbarton works. The main drawing office completes its work with the general arrangement of the valve, and the detailed drawings and component specifications are handled by a separate department. The designers are not concerned with the questions of cost or selling prices. It is for them to design a valve best suited for a particular duty, not to produce a valve to be sold within a definite price limit. Having produced a valve of the required design and strength in the most suitable material for the required duty, it is wisely recognised that the only direction in which costs can be reduced is by simplification and standardisation in the manufacturing processes. Clearly, this can only be possible after a careful consideration of every detail, the best method of performing a machining operation, the best tool for the duty, and a lay-out which ensures a perfect continuity.

From a tour of the Dumbarton valve works it is at once apparent that the essential requirements have been met in a wholly satisfactory manner. Obviously, the demands for valves of a given type are not such as to permit of a lay-out on extensive mass-production lines, but the operations at Dumbarton have been brought as nearly into line with those conditions as economically possible, manufacture being conducted on the "quantity production system." Roughly speaking, this entails component parts being manufactured in lots varying from 10 to 500, whilst assembly batches are handled in lots varying from 10 to 50.

When any particular valve has been decided upon and all necessary preparation made, orders known as "stock orders" are issued for quantities of all components required to complete the finished batch of valves. The quantities released are, of course, determined by the actual, or estimated, demand, and thus raw materials can be purchased in reasonable quantities.

When an existing works changes over to a new production, there is a natural tendency, for economic considerations, to utilise so far as possible the existing machines, even though it may be recognised they are not perhaps the ideal machines for the new duties. The Dumbarton works, however, having no pre-war history, were started *de novo*; hence the choice of machine tools was determined by requirements, the outcome being the assembly of the highest class of machine tools, not only of British, but also of Continental and American designs.

To ensure the absolute uniformity of production, which is an essential, careful consideration was given to, and a considerable amount of ingenuity displayed in, the design of jigs, fixtures and gauges, and the system in operation is

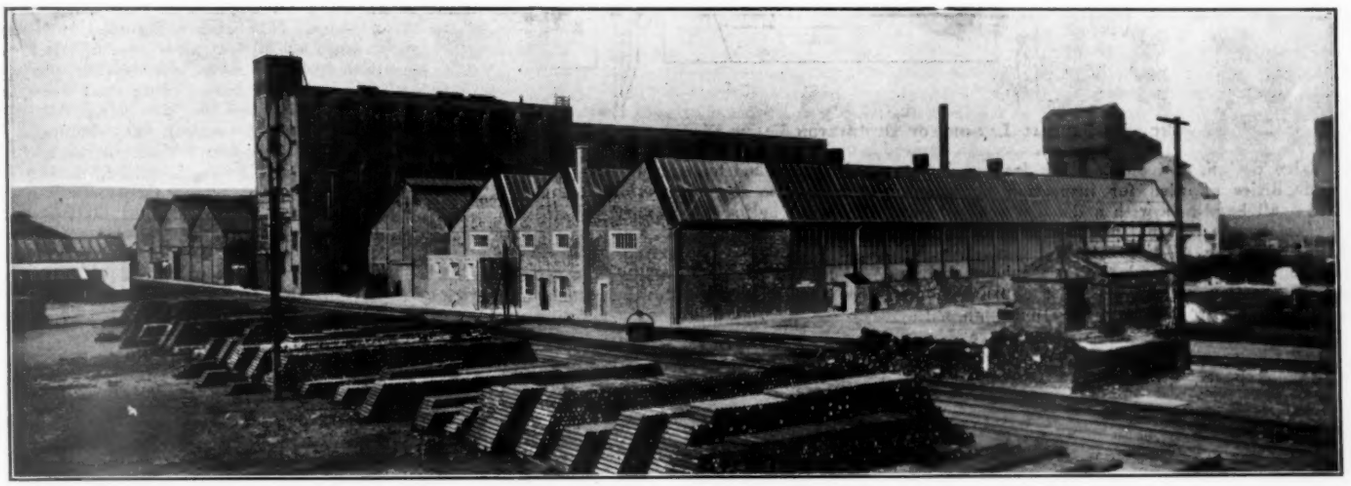


FIG. 1.—GENERAL VIEW OF DUMBARTON VALVE WORKS.

singularly complete. In the gauge room there are upwards of 20,000 limit gauges, the complete sets for each design and size of valve being carried on leaf boards, where they are easily accessible.

As evidence of the requirements in gauges, jigs, etc., we might cite an example the Babcock "Handor" parallel-slide valve, in which are embodied all the latest improvements in valve design, the outstanding feature being the facilities afforded for inspection by means of a small hand-hole with a door, which is kept in place by the internal pressure. Through this door the whole of the internal parts can be removed. The door and the cover plates, being only a fraction of the size of the usual valve cover, can easily be removed by one man without the use of lifting tackle, even on a 14-in. or 16-in. bore valve. In this valve there are 104 component parts, which call for the use of 46 jigs and fixtures, 137 tools and 174 gauges, whilst during the process of manufacture there are no less than 116 inspections. It may be specially noted that the system of inspection is very thorough and very stringent.

When the machine man has finished his work on the first two components, they are inspected and, if correct, both are stamped by the inspector; one of the specimens is retained by the inspector, the second by the workman. Periodic, or what may be termed spot, inspections are also made of the batch, and, when work on the batch is completed, the whole are passed to the inspection bench to be individually checked before the next cycle of operations is commenced; thus, interchangeability, which is most imperative in valves where renewal of component parts may be required, is ensured.

All gauges are returned to the gauge room after the completion of a job, and they are there carefully checked by master gauges before being put back into store.

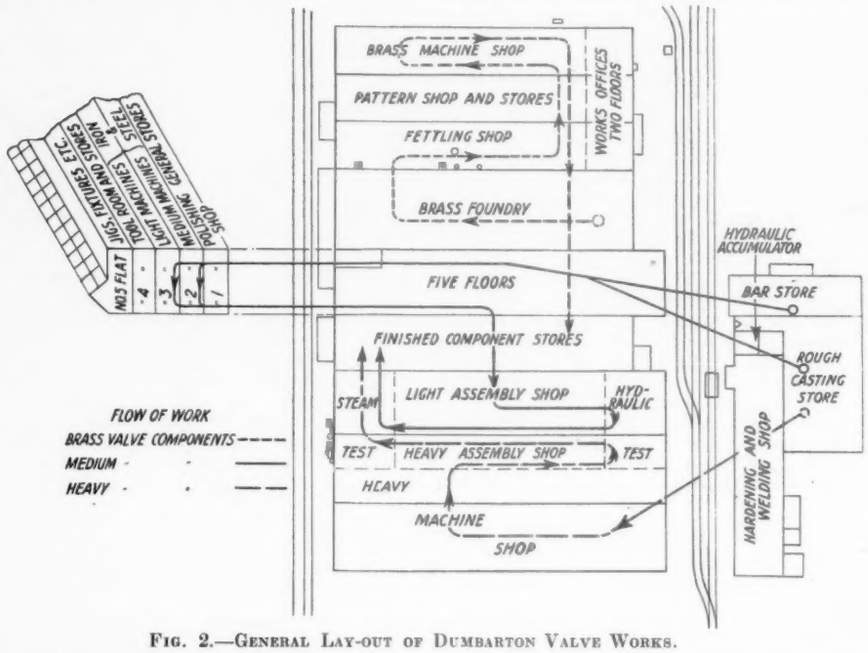


FIG. 2.—GENERAL LAY-OUT OF DUMBARTON VALVE WORKS.

It will be seen from Fig. 2 that the most prominent part of the valve works is a five-storeyed central building. This, in point of fact, existed when the site was taken over. It is a particularly substantial steel and brick building, well in line with modern ideas as regards lighting and particularly suitable for the work undertaken. The works are run day and night, and the greatest care has been given to artificial lighting. Density of illumination and absence of glare are outstanding features.

A Sturtevant system of heating and ventilating is installed throughout. The upper storey of the building is given over to the jig and fixture store, whilst the tool room, etc., occupies the floor beneath and contains a number of notable machine tools. A separate shop is laid off for the fitting and assembly of tools and gauges, as also for the building up of pattern plates. A useful tool in this department is a Thiel filing and sawing machine. A further shop is laid out as a tool stores, to which all tools are returned after use and checked. It may be noted that no tool-grinding whatever is done in the shops. Beneath the tool room is the machine shop, laid off for work on the small components of iron and steel. The equipment covers a wide range.

The medium machine shop occupies the first floor of the building and includes a battery of Herbert combination turrets; ward machines; lathes ranging from 10½-in. to 26-in. centres; milling machines; slotting machine; broaching machine and drillers, in addition to a battery of five automatics. The buffing shop occupies a portion of the ground floor, the machines including three double-head grinders and two polishing buffs. Adjoining is the press room, where are installed hand and hydraulic presses for pressing the seats into valves and faces into discs. The drawings stores and jig stores are on this floor.

The heavy machine shop is housed in a separate building covered by two bays with north lighting. The bays are served by a 3-ton and a 2-ton overhead crane. The machine-tool equipment is remarkably complete, including vertical boring mills.

At the end of the bay which adjoins the assembly shop is a Babcock oil-fired boiler with a working pressure of 2,000 lbs. per sq. in. and provision for superheating up to 900 deg. Fah. For the boiler feed there are duplicate pumps by Sir W. H. Bailey, Limited, of Manchester. At the end of the assembly bay is a hand-fired boiler which is fed with a Weir steam-driven pump. This boiler is designed for a working pressure of 500 lbs. per sq. in. and is always maintained under steam for testing purposes, the higher-pressure boiler being used when testing valves above 500 lbs. pressure. All valves are tested to their actual duty before being passed out of the works. Work in the assembly shop is very strictly sectionalised, notable sections being devoted to soot blowers which pass through the shop in batches of 500; Babcock-Cockburn-McNicol high-lift safety valves, mild-steel and gunmetal valves, etc. All water valves are tested under pressure, Glenfield & Kennedy pumps being installed to give all pressures up to 5,000 lbs. per sq. in. There is a separate assembly room for the Babcock parallel slide and the Babcock "Handor" valves. Beyond the assembly bay is the finished-part stores, though it may be noted a further stores for the smaller components is situated adjacent to the non-ferrous foundry. Whilst there is possibly nothing unduly outstanding in the method of store-keeping, it is worth noting that the stores records are all kept on the card-index system, the headings being so arranged that the storekeeper receives advice of all components ordered so that, should the urging of any particular component be necessary, it is easily brought to the notice of the superintendent.

FIG. 3.—PORTION OF BRASS FOUNDRY SHOWING FURNACES.

FIG. 4.—MACHINE-MOULDING AND POURING SECTION.

In the non-ferrous foundry are produced bronze, gunmetal and nickel-alloy castings to meet all specifications. Castings up to 1 ton in weight have been made for the Renfrew Works, but generally the castings are on the light side so that the output of 15 tons a month in special mixtures is fairly substantial. The machines comprise eight jolt-ramming machines which will take boxes up to 24 in. sq., a Pneulec sand mixer and a portable sand mixer by the P.E.A. Company. The melting plant consists of a Morgan coke-fired tilting furnace of 600 lbs. and two Morgan oil-fired furnaces each of 230 lbs., these last having proved not only the most efficient but also the most economical units; two Morgan oil-fired pit furnaces of 150 lbs. each for melting at very high temperatures and three coke-fired pit fires. The drying stoves are heated on the Mayer hot-air system. The auxiliaries include Tilghman shot-blasting table and Tilghman tumbling barrel. After shot-blasting, all non-ferrous castings are pickled in order to free them from every trace of sand and thus simplify the machining processes. There is a gate cutter and three double grinders. Castings of nickel alloys, after facing and having the risers cut off, are sent for rough testing.

The core shop and pattern stores call for no special mention. The former is equipped with machines operate with spindle speeds in excess of 2,000 r.p.m., and include capstan and turret lathes. Horizontal and vertical milling machines, Herbert slot milling machine, and H.S. sensitive drills are other equipment. A separate tool room is laid off for the brass machine shop, and a Lumsden grinder is installed for grinding the tungsten-carbide cutting tools. All finished parts from the shop are passed through the finished-part stores, from whence they must be drawn as required for the assembly. As previously stated, practically all patterns are in metal, and the complete equipment of the shop has been installed during the past year.

The heat-treatment shop is equipped with furnaces by Manchester furnaces and British furnaces, together with a large oil-fired annealing furnace by Howden-Burdon. There is also an oil-tempering bath, which is gas fired. Both the oxy-acetylene and Quasi-arc systems of welding are in service, and there is a Tilghman sand-blast plant for treating the parts after passing through the furnaces.

The raw-material stores are adjacent to the heat-treatment shop. They comprise two buildings and an open yard in which the rough castings and forgings are stored. One of the buildings serves to carry all bars, *i.e.*, steel, iron, bronze, Monel metal, stainless, etc. It may be noted that practically all the valve stems are now made of stainless steels. Samples of all castings and forgings are examined and tested before the bulk is passed into store. In a separate building the small parts are carried on racks.

A number of special tools are installed for testing and gauging. Amongst these may be mentioned a Rockwell hardness-testing machine, essentially a commercial adaption of the Brinell test, which can be used by an unskilled operator and provides an excellent check on the heat-treatment of such parts as expander mandrils and rollers, of which many thousands are tested annually. A comparator is provided for checking, by means of the travel of a beam of light on a graduated scale, any inaccuracies of flat surfaces, or in diameter. The travel of 2 in. or 3 in. of the beam of light indicates an actual difference respectively of two or three thousandths of an inch of the object under examination.

As nearly all screw threads in the factory are produced by the milling process, an accurate means of comparative inspection of threads is essential. The projector, which is used in addition to the system of checking screw threads by three wires and micrometers, projects an image of the screw thread on to a screen with a magnification of 50. It is therefore a simple and extremely accurate method of checking the form and pitch of the screw-thread gauges, since an error of $\frac{1}{1000}$ in. is shown as 0.05 in. Gauges for special profiles can also be shown, and accurately checked against an enlarged drawing of the actual profile.

The calorising shop is a separate block of buildings, where a number of different processes are used for the impregnation of certain of the ferrous components with aluminium. The products, so treated to give them heat-resisting qualities, are not strictly limited to the recognised regular products of Renfrew and Dumbarton, but also widely applied to a large variety of articles subject to high temperatures by various industries. The application of the different processes is governed by the type of service for which the article is destined. Possibly the most striking feature of this depart-

(*Concluded on page* 130.)

FIG. 5.—VIEW IN HEAT-TREATMENT SHOP.

FIG. 6.—PORTION OF LIGHT MACHINE SHOP.

FIG. 7.—VIEW IN HEAVY MACHINE SHOP.

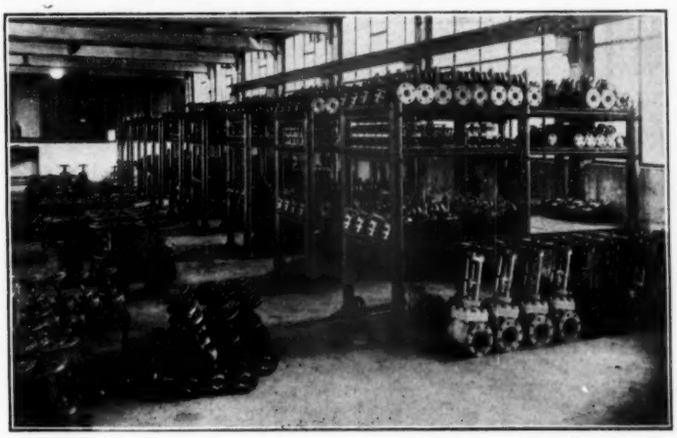


FIG. 8.—FINISHED VALVE STORES.

An Up-to-Date Foundry Lay-out*

By A. B. JACOBUS, General Manager, E. & T. Fairbanks & Company, U.S.A.

The foundry of the Fairbanks scale works in St. Johnsbury, Vt., has been kept up to date by adding modern equipment as it has become available and changing the lay-out from time to time so as to be as efficient as practicable with relation to the new machinery. The result is that at present at one point, at least, eight men do the work which formerly required forty, and great reductions in costs over only a very short time have been realised throughout this department. In fact, with the new arrangements, about 50 workers have been eliminated.

Great Savings Effected

The part where the greatest savings have been made is in the production of castings for the bases of portable scales, of which large quantities are manufactured and where, consequently, quantity production methods may be employed to great advantage. Five hundred castings are made here per day under normal conditions. The arrangement is shown in Fig. 1. The equipment consists of a rotary table with sand-slinger, drop moulds and air hoist at the moulding position. empty flasks is provided for adjacent to the conveyor. The equipment, of course, is all standard machinery, and it is by using it as outlined that the number of operators required for the day's production has been reduced from forty to eight.

For the moulding of parts in lesser quantities there are thirty moulding machines and fifteen squeezers, a large portable sand-slinger operating on tracks adjacent to the large moulding pits and a sand-cutter operated by one man. The molten metal is delivered to strategic points by ladles on the overhead monorail system, where the moulds are accumulated for pouring.

Both Light and Heavy Castings Produced

It is to be noted that a great variety of castings from small to very large are made in this foundry so that if such careful attention had not been given to the lay-out and the use of labour-saving machinery decided inefficiencies would result. Thus it will be seen from the diagram that the pits for the large castings are reached directly by the overhead monorail and the tracks

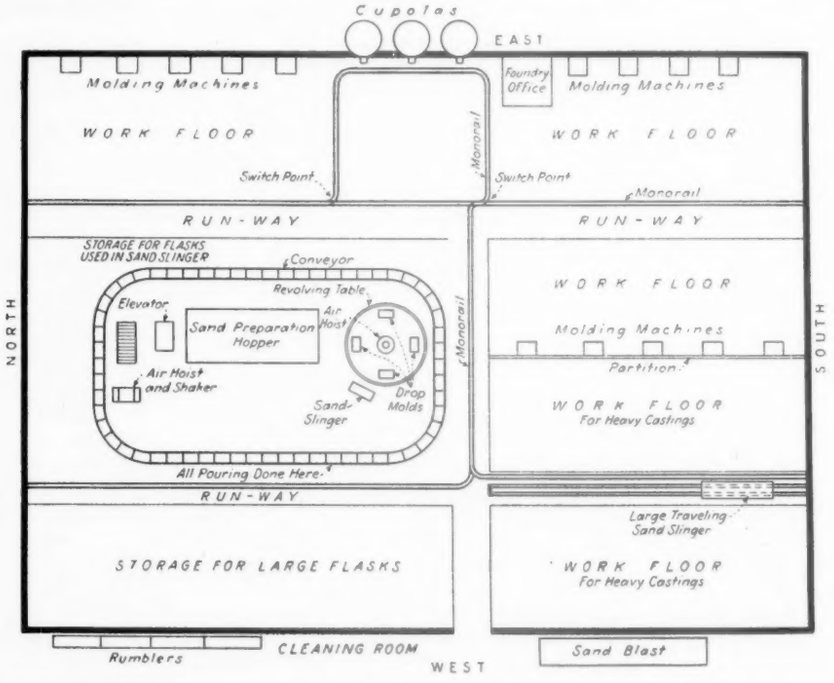


FIG. 1.—THIS LAY-OUT PERMITS THE EFFICIENT MANUFACTURE OF LIGHT AND HEAVY CASTINGS.

From the lay-out it will be seen that empty flasks are delivered on the gravity roller conveyor. The completed moulds are placed on the power-driven portion of the conveyor by the air hoist and are carried around a turn to the left where the pouring takes place as the moulds move along slowly on the conveyor. The ladles for pouring are suspended from an overhead monorail coming directly from the cupolas. By the time that the moulds have reached the other end of the conveyor the castings are cool enough to be removed. They are then picked up by the air hoist shaker, the castings are placed on skid platforms, the empty flasks are placed back on the conveyor to be returned to the moulding position, and the sand drops into a pit where it is taken by elevator to bins for storage, wetting and eventually return to the sand-slinger by mechanical means. It will be seen from the diagram that storage space for accumulations of for the sand-slinger and the aisles are arranged so that transportation by means of industrial power trucks is made easy and convenient. It is also interesting to bear in mind that this plant was started over a hundred years ago on its present site and that it has grown step by step and been managed so that it has always been kept up to date and efficient.

Accuracy Essential

Another point is that in the making of scales great accuracy is necessary both as to the dimensions and the composition of the parts. For this reason the metal is tested before pouring in the laboratory every day in order to make sure of maintaining the standard grade of iron. Proper metal is essential to accuracy in weighing, for if it is not right the parts are liable to bend and lead to inaccuracies in the results given by the finished product. In other words scales are essentially instruments and must be treated as such in their manufacture.

The routine of operations in the foundry is about as follows:

As the castings are taken from the flasks the moulder places them on skids preparatory for removal to the cleaning room. The petrol lift truck then comes along and carries the loaded skids either to sand blast or rumbler, depending upon their size. As each loaded skid is moved it is replaced by an empty one, thus eliminating extra handling. With this arrangement one petrol truck can handle all the castings after each heat, thus facilitating delivery to the rough storage stock room.

The continuous-pouring system is used throughout the foundry. Pouring commences at about 9 a.m. and continues until about 4 p.m., after which all runners and risers are removed from the floor. The electrical sand-cutter then comes along and the sand is cut and piled ready for the next day's work. The large travelling sand-slinger is used to fill the large flasks and eliminates 95 per cent. of the manual labour.

Brass and aluminium castings are made in another foundry adjacent to the large iron-foundry. This foundry is also equipped with the latest melting devices, consisting of rotary furnaces for both brass and aluminium. These furnaces are equipped with the latest electrical heat controls, making it possible to maintain the same heat for all charges which is a very important factor here. The core-room is also located in this building where cores are made in large quantities for both foundries.

High-Speed Die-Casting Machine

A fully-hydraulic and self-contained die-casting machine, known as the No. H-HP-1, states "The Machinist," has been announced by the Lester Engineering Company, Cleveland. Pressure for injection of the metal into the die is created by the built-in hydraulic pump, and the quality of the finished product is said to be improved. High speed is obtained by means of a fast-moving hydraulic toggle mechanism for die movement. This device develops a locking pressure of 35 tons, which can be utilised in pulling large cores. An automatic plunger control eliminates lost time between the various phases of the cycle. Wear between the plunger and metal cylinder is taken up automatically so that the metal pressure is always maintained.

Operation of the No. H-HP-1 machine is controlled by a single lever. Pulling the lever out will close the die hydraulically. As soon as the die is completely closed and locked the plunger operates to force metal into the die. The plunger holds the pressure on the metal for as long as required for the particular part being cast. An adjustment makes it possible to vary this time delay accurately. The plunger then returns to its original position by pushing the operating lever back and the dies are opened. Specifications are as follow:—Die opening, 5 in.; maximum die height, 12 in.; minimum die height, 4 in.; clearance between bars, 12 in. by 10 in.; metal-pot capacity (zinc), 300 lbs.; locking pressure on die, 35 tons; plunger capacity (zinc). 5 lbs.; maximum speed, 600 operations per hr.: machine weight, 3,900 lbs.

More Dates and Data

Since the publication of our list of diaries and other Christmas gifts received from our advertisers and readers, we now acknowledge with sincere thanks the following gifts from:—Universal System of Machine Moulding & Machinery, Limited, a four-days-to-a-page pocket diary, containing specialised data collected for the use of foundry executives and edited by Bonvillain & Ronceray, of Paris. It is printed in French, which really adds to its interest. Spencer & Halstead, Limited, have sent us spare parts for the excellent desk blotter and diary we received last year. From the Standard Brass, Iron & Steel Foundries, Limited, of Benoni, South Africa, comes a fine and exceedingly useful large-type calendar.

* The "Iron Age."

Vitreous Enamelling Section

DEALING WITH PAPERS PRESENTED TO THE INSTITUTE OF VITREOUS ENAMELLERS

Spraying Apparatus for Vitreous Enamelling*

By Capt. J. D. WHITEMAN

The proper selection, operation and care of spray equipment have a very close relation indeed to the quality of porcelain or vitreous-enamel finishes. Yet personal experience has shown that it is a department which often receives far too little consideration, although the most careful attention is paid to enamel control, pickling-room equipment, furnaces, charging equipment and other kindred matters. It is proposed to describe some new developments in connection with spray equipment for vitreous enamelling and to deal with a few aspects of the selection, operation and care of spray equipment which are frequently neglected.

Due to the inherent nature of the material being handled, the spray equipment used in the vitreous-enamelling industry is probably subjected to more severe service than it is required to withstand in almost any other industry. In fact this service is so severe that most reputable spray-equipment manufacturers have set the vitreous-enamelling industry apart from other industries and have designed and built equipment to meet the particular requirements of the porcelain finisher. Makeshift spray equipment or that which has been designed for use in some easier finishing fields cannot be expected to produce the superfine porcelain finishes which are demanded to-day. Such equipment cannot be expected to perform day in and day out in this severe service without troublesome breakdowns which seriously interfere with production schedules and impair the uniformity and fineness of finish for which customers clamour so persistently.

Component Parts

The main component parts of a complete spray-finishing installation are:—(1) The spray gun; (2) material containers; (3) air and fluid hose; (4) air transformers and pipe line; (5) air compressor and air receiver, and (6) spray booths and exhaust fans.

The Spray Gun

Of these pieces of equipment the spray gun is the most important, as the success or failure of the finishing operation depends to a very large extent indeed on the efficiency of the gun—it is the very keystone to the arch of successful enamelling. In the early days spray guns simply had one central hole in the air cap so that they only produced a round concentrated spray, but most spray guns to-day have an additional hole in each jaw of the air cap and the auxiliary jets of compressed air from these two spreader holes flatten the spray emitted from the fluid tip and thus enable a wider surface to be covered at each stroke of the gun.

Spray guns with air caps of this simple type are still producing excellent results with paints and lacquers, and indeed in many cases with vitreous enamel. But the latter material presents rather special problems because it is generally thicker and contains a considerably higher percentage of solids in suspension than most other materials. It is therefore necessary to use a fluid tip or nozzle with a relatively large orifice in order to obtain a sufficient flow of material, with the result that the fluid stream or jet thus produced is rather more difficult to "break up" or atomise efficiently with the ordinary air cap than are paints and lacquers.

It will be appreciated that the action of the compressed air emitted from the central hole in the air cap around the fluid nozzle is by velocity parallel to the fluid stream and it therefore acts on the outside of the fluid stream and not on its core. Consequently as the outside of the fluid stream is torn away a point is reached where the stream breaks completely crosswise into comparatively large droplets which are carried along with the air with little further action to break them up.

The spreader jets do have some atomising action by their deflection of portions of the central fluid stream to form the fan spray, but with the simple, single-hole spreader jets this action cannot be strong without an irregular-shaped or split spray resulting, leaving coarse atomisation in the centre of the pattern. It was therefore necessary to find a different means of utilising the compressed air and, after considerable experiment, a new type of air cap has been recently developed for vitreous enamel which involves new principles of atomisation.

A New Air Cap

This new type of air cap has auxiliary atomising jets around the central hole, and also twin spreader jets instead of the previous single spreader jets, and the combined action of these jets produces a violent turbulence or agitation of the fluid that is quite impossible with the earlier type of air cap. The result is that the new air cap produces a superbly-atomised coating, and also a softer final spray without any danger of a split or distorted pattern. The new and better type of air cap is unquestionably producing magnificent results in the application of vitreous enamels; for instance, soon after it had been adopted by one well-known manufacturer of refrigerators, he stated that he could pick out every cabinet in his factory that had been sprayed with the new cap—so outstandingly was the finish improved.

The greatly-improved action of the new type of air cap enables the spray to be spread to greater width of fan than with former air caps, which permits a somewhat different technique in applying the coating. With the concentrated spray produced with the earlier form of air cap—frequently with coarse atomisation in the centre of the pattern—it was necessary to hold the gun at some distance from the work and to apply to narrow and thick film at each passage of the gun over the surface. This method of working made overlapping of strokes difficult without danger of rippling the surface or applying too thick a coat unless a helter-skelter "dusting" of the surface was resorted to which showed up the poor atomisation in small lumps in the fired surface.

The new type of air cap allows the coating to be built up of thin, drier, well-atomised films produced with a rhythmic handling of the gun in wide, parallel strokes with the nozzle held closer to the surface. This method results in an evenly-distributed coating of uniform thickness and colour—free of wavy, "orange peel" and blotchy appearance in the fired surface, and also enables the application to be made much quicker than with the earlier type of air cap. Many of the previous troubles that occurred in firing, such as hair lines, tearing or blistering due to too heavy a coating, have been overcome with the new cap, and it is likely that the drier coating it produces will help to prevent the rusting difficulties that have happened in the past owing to the coating being too wet.

Very careful attention should be paid to the choice of spray guns, as there are very great differences indeed between the many guns that are now on the market, and it may be of assistance to enumerate briefly the qualities that a good spray gun for vitreous enamel should have:—

(1) It should be of modern design, durable construction, and specially intended for the severe duty of spraying vitreous enamel.

(2) The fluid tip and air cap should be suitable for the viscosity and specific gravity of the material to be applied and also for the method of feed to be used. A nozzle combination that is ideal for gravity feed is often quite unsuitable for pressure feed.

(3) The air and fluid passages of the gun should be as straight and unobstructed as possible, to allow free flow of air and fluid.

(4) The gun should produce a wide, well-atomised spray of regular pattern with the material evenly distributed over its whole area. There must be no splitting of the spray or undue heaviness in its centre or outer edges, no suggestion of "raining" or spattering whatever, and the edges of the pattern should be cleanly atomised with no specks or overspray.

(5) The air cap, nozzle and needle should be constructed to resist wear and corrosion.

(6) The width of the spray should be easily adjustable to allow for variations in the material and the sizes of work handled.

(7) The working parts of the gun should be designed for easy and rapid repair or replacement, enabling it to be maintained in good condition at all times in the severe service in which it is used.

(8) The gun should be well balanced and fit the operator's hand comfortably so that it can be used for long hours of work without undue fatigue.

Material Containers

The next item of equipment to be considered is the question of material containers, and here there is considerable diversity of opinion. The four methods of feed are:—(1) Gravity feed cup attached to the gun above the gun body; (2) suction feed cup attached underneath the gun body; (3) separate large overhead gravity feed container connected to the gun by a length of fluid hose, and (4) separate pressure-feed tank standing on the ground and connected to the gun by suitable lengths of air and fluid hose.

The first two methods are intended principally for dealing with small work or in cases where the material is frequently changed; the advocates of the gravity-feed cup can rarely see any virtue in the suction-feed cup underneath the gun and *vice versa*.

Spray guns with a gravity-feed cup are very good for heavy materials and they can be used at a lower pressure than a gun with a suction-feed cup, as the material falls by its own weight to the nozzle of the gun, whereas a higher pressure has to be used with the suction-feed cup to lift the material up to the nozzle.

The separate gravity-feed container suspended 6 to 8 ft. above the spray gun has been very

* Paper read to The Institute of Vitreous Enamellers in London.

popular in the vitreous-enamelling industry for a good many years, but enamellers both here and in the United States are rapidly changing over to pressure feed and enamellers who have not done so are strongly advised to consider the many points in favour of this type of feed.

Unless specially mounted on strong platforms it is not usually safe or practicable to have gravity containers of more than 10 galls. capacity, whereas pressure-feed tanks can be supplied in almost any size up to 55 galls. and even as large as 200 galls. if required. In cases where the gravity containers are not mounted on platforms above the spray booths—the block and tackle used to hoist them aloft may break even if the rope has a wire centre or it may not be securely fixed—material in gravity containers is easily spilled, dust and dirt can get into the enamel, the material can only flow at gravity rate, and the principal advantage of the gravity container is that it is cheaper in first cost than the pressure-feed tank.

The chief advantages of the pressure-feed system are:—(1) More uniform control of the material is possible; (2) a very large amount of work can be done before refilling is necessary, thus obviating the waste of time than is entailed in constantly refilling smaller containers; (3) dust and dirt are prevented from getting into the enamel as pressure-feed tanks are airtight; (4) the spillage and consequent waste when refilling smaller containers is eliminated; (5) the material is fed to the nozzle of the gun more uniformly and in greater volume than by any other method, particularly if heavy materials are used; (6) less air pressure is required to obtain speed of operation; (7) spray dust and waste of enamel are reduced to a minimum, and (8) continuous mechanical agitation of the material to keep it in proper suspension is ensured by providing an air motor-driven agitator.

Pressure-feed tanks for vitreous enamelling are constructed of non-corrosive material; they are extremely easy to operate, and they have full-diameter openings for easy filling and cleaning, and separate insert containers are available, if necessary, still further simplifying those operations.

Air and Fluid Hose

It is essential that the hose and its connections be of sufficient size to deliver the pressure and volume of air and the proper volume of material necessary to the efficient operation of the spray gun. The author has sometimes been amazed, in visiting plants, to see the greatest care and attention paid to the spray equipment, and yet the guns were not being allowed to produce their best work on account of hose or connections that were too small, and thus restricted the flow of air and fluid.

Hose gets very rough treatment in the average shop, and experience has shown again and again that the best is cheapest in the long run. Hose must be made to a specification that will enable it to stand up to the rough usage it is bound to get. Fluid hose must be used that can be relied upon not to shed pieces of its inner lining and thus impair the finish. It must possess great flexibility and lightness, coupled with strength, so that it will not tire the operators by tending to twist the guns in their hands. For full-size production-type spray guns, the air hose should have an internal diameter of at least $\frac{5}{16}$ in., and the fluid hose from gravity-feed containers or from pressure-feed tanks should not be less than $\frac{3}{8}$ in. in diameter.

Air Transformers

The fourth class of equipment to be considered is the air transformer and the pipeline conveying the compressed air from the air receiver to the transformers. Compressed air always contains a certain amount of moisture, oil and dirt, which must be removed if a satisfactory finish is to be obtained and "jumping" of the enamel is to be avoided. The air transformer is therefore an indispensable item of equipment, as it definitely eliminates these impurities, thus ensuring a supply of clean and dry compressed air at the spray gun.

The air transformed also permits the operators instantly to vary the air pressure for different materials or effects by simply turning a regulating screw, thus making it unnecessary to leave the spraying point to adjust the pressure at the air compressor, which may be installed some distance away. The regulating valve of the air transformer can be set for any desired pressure within the limits of the air compressor, thus ensuring a uniform pressure at the nozzle of the gun, and therefore a uniformly-coated surface.

The air transformer allows each operator to work at different pressures, if necessary, according to the type of work he is doing, but if all operators are working at the same pressure, the air transformers are available with locking devices, so that the foreman can set the air pressure and prevent it being interfered with by the operators. An air transformer should be provided for each spray gun, and it should be inserted in the air line at the closest convenient point to the gun—preferably mounted on the right-hand front edge of each spray booth.

The purifying action of the air transformer is automatic, and the only attention necessary is to open the drain tap at the bottom of the instrument once or twice daily to allow accumulated moisture and oil to escape. The pipe line conveying the compressed air from the air receiver to the air transformer should be of ample size, and it should not normally be smaller in diameter than $\frac{1}{2}$-in. gas. Long runs of pipe line should preferably be $\frac{3}{4}$ in. dia.

Galvanised-iron piping should be used to ensure freedom from rust flakes and other impurities due to condensation. The pipe line should have a slight fall towards the air receiver, and provision should be made for drainage at suitable points so as easily to dispose of condensation in the line. More difficulties are traceable to insufficient air pressure at the spray gun than to almost any other source. The air pressure at the air receiver may be sufficient, but, due to pipes and hose that are too small, pressure at the spray gun may be considerably below expectations. In this connection, it has frequently been noticed that in shops that have made their own gravity containers the hole in the outlet cock is frequently too small, which interferes considerably with the flow of enamel.

Air Compressor and Air Receiver

The air consumption of a spray gun and the output of an air compressor are usually expressed in terms of cubic feet per minute, and it is essential to choose an air compressor with an output in excess of the consumption of the spray guns in use; otherwise the pressure will rapidly fall away, with the result that the material is imperfectly atomised. The "swept capacity" of the compressor—that is, the product of the bore, stroke and speed—must not be confused with the free air delivery. It is the latter which should be equal to or slightly exceed the total consumption of the spray guns where they are in practically constant use. No compressor is usually more than about 80 to 85 per cent. efficient—that is to say, it will only deliver about 80 per cent. of its swept capacity.

So many people, when talking about compressed air, consider only the question of pressure, ignoring entirely the necessity for a suitable volume of air to maintain that pressure, having regard to the consumption of the spray guns in use. Frequently an air compressor will build up a pressure as high as 200 lbs. per sq. in., but it will only be capable of delivering $\frac{1}{2}$ cub. ft. of air per min. In such a case, the pressure would be maintained only until the trigger of the gun was pulled, and then it would rapidly drop to zero.

In order to reduce to a minimum the amount of oil carried over into the air line, an air compressor running at a relatively low speed should be chosen, as this is also likely to last longer than a small machine running very fast. It is sound policy to install a separate air compressor for the spray-finishing department to avoid running the larger sand-blast air compressor when only the spraying equipment is in operation—and it makes for safety in case of breakdown of the larger machine just when the spraying department is at its busiest.

As much care should be given to "running-in" a new air compressor as is bestowed upon a new car. The oil should be changed frequently when the compressor is new, and whilst ensuring that there is sufficient oil in the machine at all times, one should be equally sure that there is not too much. Over-lubrication of an air compressor is nearly as detrimental as under-lubrication. Over-lubrication causes carbonisation of the valve parts, overheating, and increases the power absorbed—quite apart from the serious troubles caused by excess oil that is carried into the air line.

The air compressor should be installed outside the spray-finishing department, so that there is no danger of it drawing in air in which there may be abrasive dirt or even vitreous enamel, which are far from beneficial for the inside of the machine. The air compressor should be installed in the cleanest and coolest possible place, and, if practicable, the air inlet should be extended to the outside atmosphere—suitably protected from the weather, of course. The compressor should be provided with a filter over the intake opening, and it is important to clean this filter regularly; an air compressor cannot breathe in efficiently if the filter is clogged any more than a person with a cold in the head. An air compressor should be installed in an easily-accessible position, and as far as possible in a good light, as otherwise it will be found that it will not receive proper cleaning and attention; air compressors are so often installed in dark corners in an almost unapproachable position.

The air receiver should be installed as near as possible to the air compressor, and a receiver of ample size is a very good investment, as the use of compressed air is hardly ever constant, and the larger the receiver, the better will the air compressor meet any suddenly-large demand on the air supply. An air receiver of ample proportions not only prevents pulsations in the air line, thus ensuring the steady pressure that is essential for spraying, but it also allows the air to cool so that oil and moisture are precipitated and may be drawn off at the receiver instead of passing into the air line. The air receiver should be tested to twice the working pressure for which it is used, and it is very important to ascertain that the safety valve and pressure gauge are constantly maintained in good working order—a compressed-air explosion is a very dreadful thing.

Spray Booths and Exhaust Fans

Spray booths for vitreous enamel should be made of galvanised iron to prevent rusting, and they should be provided with a device for reclaiming the maximum amount of excess sprayed enamel. A system of properly-designed baffles should be fitted to the back of the booth, to ensure an even distribution of air over the whole area of the booth and also prevent a large proportion of enamel dust from passing through the exhaust fan and stack pipes to the exterior of the building. The baffles therefore prevent waste of material, protect the exhaust fan and also make for a cleanly exterior, which is very important in some congested districts. They should be easily removable for cleaning purposes.

The spray booths should be so placed that the operators have the maximum amount of natural light and, if artificial light is necessary, it should be so arranged that no shadows are cast on the work. It is often surprising how a little attention to the important questions of lighting will result in a great decrease of rejections in the inspection department.

The exhaust fans should preferably be of the type in which the electric motor driving them is outside the discharge pipe, as otherwise the enamel dust will very soon damage the motor, resulting in expense and interference with production schedules. The exhaust fan should have a capacity that will produce an inward velocity of air through the booth of from 90 to 120 linear ft. per min. Too high an air speed through the booth will cause drafts and result in undue waste of enamel, but too low a speed will, of course, be insufficient to protect the operators.

The discharge pipe from the exhaust fan should always be slightly larger in diameter than the fan and the pipe should be as straight as possible, so that a pressure is not set up against the fan. If bends are necessary they should be of very ample radius.

Suitable weather cowls should be fitted to the discharge stack pipes, but it is very important to see that sufficient space is allowed between the top of the pipe and the underside of the cowl to allow the outgoing air to escape freely without setting up a back pressure on the fan.

Useful Pointers

There is, of course, a right and a wrong way to use any tool—and the spray gun is no exception to that rule. It is not a squirt, but a high-precision instrument which must be handled properly and be correctly adjusted if it is to produce the fine finish expected of it.

Enamellers should take the fullest possible advantage of the specialised knowledge of their spray-equipment manufacturer in these matters if they are in any doubt—often he will be able to give their operators invaluable training in the correct use of the equipment and eradicate bad habits that may have crept in to the detriment of costs and quality of finish.

For instance, many operators acquire the bad habit of spraying in irregular strokes with the trigger of the gun fully pressed all the time, and although they often become quite skilled in obtaining a reasonable result in this way, they would do infinitely better if they used the gun correctly in steady, even, regular strokes, releasing the trigger momentarily at the end of each stroke. This correct method of using the spray gun results in the "feathering out" of the ends of the strokes so that proper coverage is obtained in subsequent overlapping, and it also prevents the accumulation of material at the end of each stroke that occurs if the motion of the gun is stopped over the surface while the trigger is pulled back.

The width of spray must be so adjusted that it is suitable for the type of surface to be treated; in most good spray guns this is done by simply turning a micrometer control at the back of the gun. For spraying small cast-iron parts many operators prefer the simple round spray, but in most cases better results can be obtained with a narrow fan spray and also a saving in material as the gun can be held closer to the work.

The best methods to use in spraying the several sides of awkward castings must be carefully studied, so that the pieces are placed and sprayed in such a manner that a minimum amount of dust is deposited upon the finished surface and the smallest possible amount of enamel is used.

The fluid pressure must not be too high for the atomising air pressure available. With enamels having a specific gravity of about 1.87 the gravity container should be from 4 to 6 ft. above the gun, and in the case of pressure-feed tanks a fluid pressure of about 10 lbs. per sq. in. is quite sufficient. A good way to test the fluid pressure is to turn off the main atomising air pressure, and then if the fluid is shot straight out from the nozzle of the gun across the room on pulling the trigger the fluid pressure is too high. In the same way if it only drops out of the nozzle of the gun the pressure is too low, and the happy medium is a slow, smooth-flowing stream of material between the two extremes mentioned.

The regulating valve, pressure gauge and safety valve of pressure-feed tanks must be kept clean and in good working condition. The best work cannot be produced if these fittings are out of order. The only other care that pressure-feed tanks require is to flush them out with water thoroughly from time to time.

The drain taps on the air transformers and on the air receiver must be opened once or twice daily to allow accumulated moisture and oil to escape, and the filters in the air transformers must be changed from time to time as a clogged filter cannot function properly. Considerable wear on the diaphragms of the air transformers can be avoided by releasing the regulating screw at the end of the day's work.

Clean spray booths aid greatly in the production of quality work; they must be washed down thoroughly and regularly. The scrapings or excess enamel that accumulate in the booths should be wetted down frequently to prevent the small particles from flying about and getting on the sheets or pieces being sprayed.

The fluid hose must be removed from the guns every day and be thoroughly flushed out with water.

An efficient enamel-control system that will guarantee an enamel supply of uniform and suitable consistency for the spray gun will greatly aid in the successful operation of the spray equipment. If a change is made in the enamel mix, be sure that the fluid tip and air cap of the guns previously used for the old mixture are suitable for the new mixture. The same nozzle combination will handle a wide range of materials, but air caps and fluid tips are designed for different materials, and the correct combination will make all the difference between a good finish and a superb finish.

The spray guns must be cleaned, both inside and outside, with warm water at the end of every working period, for clean tools usually denote a good workman. No tool can be expected to give long trouble-free service unless it is given proper care, and probably the most frequent cause of poor finishes is traceable to dirty equipment. Nothing is easier to have—nothing is more necessary—than clean spraying equipment, yet how often does one see an operator trying to produce a fine finish with a gun that is covered with dried deposits—a speck of which if dropped on the finished work will mar it.

No operator must use the tangs of files or other sharp metal instruments for cleaning the holes in the air cap of the gun; if they do they are almost sure to injure the holes, and that means that the pattern of the spray produced will not be perfectly shaped and the finish will be seriously affected. The caps must be soaked in warm water and the holes then cleaned very carefully with a pipe cleaner, pointed wooden stick, broom bristle or other soft instrument. The moving parts of the guns must be given a spot or two of light lubricating oil regularly and also the fluid needle packing, which tends to become hardened after a time.

The practice of allowing the operators to make adjustments to spray guns is not good, and it is suggested that there be one man trained to maintain the guns in good condition and to be responsible for them. It is also suggested that it would be well worth while to keep one or two spray guns in reserve, so that a new gun is instantly available if a gun on production should become defective.

In the same way it is advisable to hold a small stock of the spare parts that are most frequently required, so that there is no delay in obtaining the necessary parts when they are badly wanted, and, in this connection, it is pointed out that it is desirable when fitting a new fluid nozzle also to fit a new fluid needle at the same time, as an old and a new part cannot be expected to seat together as well as two new parts.

How Colouring Oxides are Affected by Variations of Enamel Composition*

By W. BALL

Colouring oxides for use in vitreous enamel are prepared solely from metallic bases of course, and until recent years the colourmaker started with crude metallic ores or salts, just as the ancients stained glasses and enamels with raw minerals the composition of which they knew little; but nowadays the maker commences the actual manufacture of the colours with pure chemicals. This increases the cost of the colour batch considerably, but is justified by the increased uniformity of the finished product. For instance, iron was commonly introduced into the mixing as mill scale, iron sulphate, or natural iron chromate, all now superseded by the pure red oxide of iron.

Manufacturing Process

First of all the materials are weighed out and intimately mixed; if none of them is soluble they are wet-ground together and dried, or if this is not possible they are dry mixed. They are then given the first fire, which varies, of course, according to the colour which is being made, some typical figures being:—Yellow, 1,000 deg. C.; brown, 1,220 deg. C., and blue, 1,320 deg. C.

The oxides are usually fired in the same way as pottery, that is, they are placed in what are known locally as "saggars," these being fireclay receptacles which can be stacked one above the other. They are then fired, very often in a beehive-type kiln, which is of the direct-fired type, or in a complete muffle kiln. The firing is usually by oil or coal with the exception of special colours, which may be fired in an electric furnace to ensure definite control of the temperature and furnace atmosphere. Accurate control of the firing is essential and several time-temperature recording pyrometers are used.

After the first firing, the colour is broken up and refired, or if the original materials were only dry-mixed it is wet-ground after the first fire, dried and refired. After the second fire the colour is usually uniform and satisfactory, and is crushed ready for grinding. The condition of samples of fired but unground oxides varies from powder through the various stages to complete vitrification, according to the materials used and the fire to which they have been subjected. The oxide is now ground in water to impalpability and, as an example of the care which is taken, all oxides are passed through a 200-mesh per sq. in. sieve when they are taken off the mill.

Pan mills are usually used as they give much finer grinding with less contamination than is possible on a cylinder. A special type of granite, known as "chert" stone is used for the base and stone of the mill, and porcelain for the sides. A charge of 60 lbs. usually takes from 50 to 70 hrs.' continuous grinding.

The oxide is dried and sieved through an 80- or 100-mesh sieve. It is now tested for colour against the "standard," which is a sample taken from the first batch made. Each new batch is tested against this standard by a trial milling and checked for colour and general quality. It will thus be seen that the preparation of the

* A Paper presented to The Institute of Vitreous Enamellers in Manchester.

oxide is by no means a simple procedure and very careful control is needed throughout to ensure a uniform result.

Formulæ for Colours

Before discussing the question of how the oxides are affected by variations of enamel composition, the following formulæ for typical base oxides will no doubt be interesting:—

Brown.		Blue.		Black.	
Red oxide of iron	6	Alumina	12	Red oxide of iron	3
Green oxide of chrome	6	Zinc oxide	5	Nickel oxide	1
				Manganese dioxide	1
Zinc oxide	40	Cobalt oxide	3	Cobalt oxide	6

Uniformity of colour in the enamel is one of the main aims of the colourmaker, and to obtain this the most stable combination of materials is required. In some cases, such as light blues, the same material not only develops the colour required, but also forms a stable compound which resists the attack of the enamel. Theoretically, to give a uniform colour under variation of conditions the oxide should remain in suspension in the enamel without any combination taking place between them. In actual practice this only occurs in rare circumstances.

One of the most stable oxide colours is the blue-green or light blue; in this case the cobalt is firmly anchored to alumina as a cobalt aluminate, or in some cases with zinc and alumina as a cobalt zincoaluminate. It resists the attack of practically any type of commercial enamel.

Colour Variation Difficulties

There are two main types of colour variation which trouble the enameller. In the first the oxide gives a satisfactory colour at a definite temperature, but any variation of heat gives a different colour, and where a casting has varying thicknesses this variation in the heat received by the enamel is unavoidable. The second type is where the oxide can only be used in a suitable enamel or type of enamel.

Taking the first type of colour variation, this is very much more troublesome on cast iron than sheet iron; for this reason the following remarks apply mainly to cast-iron enamels.

There are several reasons why greater colour variation is experienced in cast-iron enamels than sheet iron. There are so many extra points to be considered in the construction of the cast-iron enamel, such as suitability for working direct on castings of various qualities, a good "flow" to cover any defects, together with freedom from "crawling," freedom from rust-spotting, and with a resistance or degree of resistance to acids, that very often the question of whether the enamel will produce a stable colour with an oxide addition is the last thought which strikes the enamel maker. This is particularly so when he intends to rely on someone else to make the oxides for him!

W. J. Baldwin, in the Journal of the American Society, says: "The stability of mahogany colours is improved if the boric-oxide to sodium-oxide ratio is greater than 1. (The mahogany referred to is a red oxide of iron base, which is not used in this country on account of colour variation.) This composition is not necessary for other colours, but generally improves the suspension of the enamel, and less clay may be used in the mill charge with resultant brighter colours. The replacement of calcium fluoride by sodium fluoride affected the colour of the iron oxide reds adversely and increased the fluidity of the enamel." (A red oxide of iron used as a mill addition gives a good brick-red colour, but very easily fires away to a dirty yellow or grey.)

Henrivaux, a French authority on glass batches, say: "The oxides employed in the coloration of glass may give different tints according to:—(1) The state of oxidation in which they are employed; (2) the nature of the glass in which they are incorporated; (3) the degree of temperature to which they are submitted, and (4) the duration of this temperature," and these remarks apply to a great extent to enamels also.

The colour which is most commonly used on cast iron is grey, and by an unfortunate coincidence this is a colour likely to give variation according to the enamel in which the oxide is used and the temperature of the firing.

Use of Black Oxide

If a prepared grey oxide is used, in which the colouring matter has been actually combined with a stabiliser, which is often also an opacifier, this variation is considerably reduced, but with a view to economy some enamellers use a small addition of black oxide to the frit, maybe with the addition of an opacifier also. Although this sometimes gives an apparent saving by reducing the cost of the mill addition, it is necessary to consider the matter more carefully, as any colour variation is an expensive matter and can often be traced to this practice, which it is thought originated in America, where a much higher percentage of the castings enamelled are specially designed for enamelling, and also there is a much more rigid control of the milling and firing processes.

Incidentally, this use of a small percentage of black oxide, particularly if used in a white frit, gives a colour which is extremely difficult to reproduce when using a different enamel and oxide, as the finished colour is the result of the black oxide going into semi-solution in the enamel. This develops a unique mixture of tones, and what on first sight seems to be the easiest of colour matchings turns out to be the most difficult. This practice also usually involves a great deal of trouble in the assembly shop owing to variation in colour.

The range of frits in use for normal commercial enamelling direct on cast iron consists of:—(1) The "ordinary" type, firing at 730 to 740 deg. C. (sometimes referred to in a rather disparaging tone as the "soft" or "soluble" type). This is not always justified, as the fusibility of an enamel is no accurate guide to its resistance to wear. (2) The "hard" type, firing at 760 to 780 deg. C., is now coming into favour with the improvement in casting design which permits the higher temperature without warpage. This usually gives a very high gloss, and the best enamels of this kind work as easily as the "soft" type, and also have a degree of resistance to weak acids and alkalies, besides withstanding a very severe "scratch test." (3) The "acid-resistant" or "acid-proof" type may be divided into three sections:—(*a*) The "easily fusible," firing at 730 to 750 deg. C.; (*b*) the "high temperature," firing at 780 to 810 deg. C.; and (*c*) there is still some acid-resistant enamel used at matt ground coat, and this enamel seems to have other characteristics which distinguish it from (*a*) and (*b*); it usually fires at 740 to 760 deg. C.

A typical example of variation according to the enamel used is provided by the oxides which contain cobalt, such as a black oxide, particularly when used at a low percentage, and it seems probable that the cobalt displaces some of the soda, especially where the whole of the soda is not combined as a boro-silicate or alumino-silicate.

It will be seen that a sound knowledge of both enamels and colour oxides and their composition is essential to anyone wishing to produce good frits which will not only "enamel" well, but also give steady colours with an oxide addition.

Samples of fired trials (exhibited at the meeting) showed the difference in colour produced by the use of the same oxide in enamels of varying compositions, where the suitable oxide had not been chosen for the particular enamel. These trials showed how important it was to use the correct oxide for the enamel which you wish to use. Given the co-operation of the enameller, it is possible to produce an oxide to give a stable colour in any commercial enamel, with only occasional exceptions.

Suitable Enamels for Carrying Colour

The second type of colour variation is that where an oxide will only produce a satisfactory colour in a suitable enamel. The outstanding example of this is a bright-red oxide. This is a complex combination of cadmium and selenium with sulphur. It is an exception to the usual rules in that it is not fired at as high a temperature during its preparation as it reaches in the enamel, and also sulphur is used to produce the colour, whereas in all the branches of the ceramic industries great care is usually taken to avoid its presence in any shape or form.

Very few cast-iron enamels are suitable for cadmium and selenium colours. This is not usually due to the presence of any one material as is generally supposed, but depends on the combination of the materials. The question of grinding is also very important in this case; the finer the grinding the brighter the colour. An interesting point is that it is possible to grind an enamel containing a cadmium colour very much finer than is usual without signs of "crawling" showing.

Bright green oxides are usually a mixture of a blue green, which is a combination of a cobalt alumina blue and a cadmium yellow; for this reason the frit in which it is to be used must be suitable for the cadmium yellow otherwise the blue will be developed but not the yellow to give the green, or in a moderately suitable enamel the yellow will fire away at an increasing heat, giving a variation from a meadow green to blue green.

Another troublesome colour is pink. A pink oxide may be either a lime tin base with a small percentage of chrome oxide; or a gold colour. Neither give a very steady colour and neither are as bright and pure as is often required. A common trouble is that the enameller is expected to match a pink pottery glaze. In this case the glaze is specially designed to suit the pink oxide. A chrome tin pink is used and the glaze is in the kiln at least eight hours before the glaze matures. The glaze used is high in lead and the glaze manufacturers have encountered similar difficulties to vitreous enamellers in attempting to produce a good colour in a leadless glaze. The gold pink is very expensive and is mainly used by dry-process bath enamellers, who find that the increased stability makes its use an economy. Samples were exhibited showing two pink oxides in a standard glaze and also in a special glaze, which illustrated the great difference which the special glaze made.

The Fundamental Properties of Clay

(*Concluded from page* 128.)

either. He thought that the general experience would be that those in the industry ultimately realised that they had to make certain revisions in order to allow for the differences in manufacture due to hard and soft water.

MR. BALL quoted a startling experience due to a change of water, production being thrown out of gear until the cause was discovered on consulting the water company.

The CHAIRMAN said that one could not use the same set up with two widely divergent waters. In the particular problem he had in mind, no matter how they altered the set up, they could not make it work.

MR. BALL, alluding to ground-coat set up, suggested that variation in solubility could be caused by variation in milling practice. The question of milling fast or slow entered into this problem. Thus they could work with as much water as was sufficient to get the enamel off the mill in what was assumed to be the correct consistency, or, on the other hand, get the enamel off thicker and thin it down afterwards.

ACID RESISTING ENAMELS

A. England, M.Sc. (Mch.)

W. Ball

W. E. McCalla

N. Bowen

B. A. McCalla

These five enamel experts have evolved what is, without any doubt, the finest range of acid resisting enamels for use on cast or sheet iron at present being offered for sale.

PROOF

The amount of these acid resisting enamels used by the trade is greater than the total amount of all others combined.

THE UNIVERSAL REPORT OF ALL USERS AFTER TESTING ALL OTHERS IS THAT THEY ARE THE BEST ON THE MARKET.

Our demonstrator would be glad to bring some enamel and apply it at your works and good results are guaranteed. It fires at 750 degrees centigrade, and is as Readily Workable as ordinary enamels.

ONE GREAT ADVANTAGE OVER ALL OTHERS IS THAT ANY COLOURED ENAMEL CAN BE PRODUCED.

ENAMELS of every description for SHEET or CAST IRON supplied wet or dry.

COLOURING OXIDES—unquestionably the finest selection in the trade.
ENAMELS for BRONZE PLATES and JEWELLERY.
EXPERT MATCHINGS BY RETURN OF POST.

Phone :
Blythe Bridge
101, 102 & 103

Grams :
"Blycol,"
Blythe Bridge, Staffs

Blythe
COLOUR WORKS Ltd
CRESWELL, Stoke-on-Trent
Established 1870

DIEPPE (France)
BRUSSELS (Belgium)
TURIN (Italy)
DEVENTER (Holland)

EAST LIVERPOOL (U.S.A.)
ONDA (Spain)
OPORTO (Portugal)
TEPLITZ SCHONAU
(Czecho Slovakia)

EST. 1870 BLYTHE QUALITY

The Fundamental Properties of Clay

INFLUENCE OF TOWN WATER SUPPLY

MR. F. H. CLEWS' Paper on "The Settling and Anti-Settling Properties of Clay" gave rise to a very interesting discussion on the fundamental properties of clays. The discussion was opened by MR. S. HALLSWORTH, who said there was one very interesting point regarding the effect of addition of salts, and the testing of it through a mobilometer. His company had undertaken many experiments in order to obtain a test that would measure the consistency of enamel regardless of the salt added to give it viscosity or mobility. In another direction, particularly with enamel set up by borax or magnesium sulphate or anything of that kind, was any test known to be sufficiently reliable for consistency? Such a test on this basis would not, for instance, be used for sheet-iron grip coat. The relation of weight per pint was useless, because in adding a small quantity of borax solution the weight per pint would not be affected, but it would affect mobility. In regard to measuring the mobility of enamel, and also its draining properties, if they added a borax solution to the grip coat, it would not affect the flow through a given orifice, although it was seen to have some effect on the enamel when they came to check it. Turning to specific gravity, Mr. Hallsworth said a similar result occurred. He did not know whether anyone present had tried making tests on these lines. He was aware that the American experts put forward many suggestions, but in his experience they did not always put them to use.

Utility of the Mobility Test

MR. CLEWS, while disclaiming to speak authoritatively, said it struck him that there was something to be said for the mobility type of test. Whether it was the most definite or not was not for him to say, but he thought that on the theoretical side it was on right lines. This was so in the sense that they were not measuring one property only, because the test measured two simultaneously. Probably there were other composites than these two which ought to be measured, and in that sense it was an advance on any single measurement such as that for specific gravity or even viscosity, because there was the intercept on the stress axis—the yield value—as well as the mobility part—the slope of the curve—to take into account. As one speaker had said, the addition of a small amount of electrolite could not alter the clay weight per pint, although it could easily alter the consistency of the enamel.

Influence of Electrolites

MR. HALLSWORTH explained that he ought to have mentioned as supporting the lecturer that where no electrolite was added the flow test or the mobility type of test was exceptionally good. Where they simply had clay frit and water and clear oxides the flow test worked out exceptionally accurately, but immediately one started adding electrolites the flow test was unsatisfactory. Replying to Mr. Clews on this point, Mr. Hallsworth remarked that while keeping to clay and water only they could control the enamel, but as soon as they introduced clay which had electrolite added to it, control of the enamel was adversely affected, inasmuch as the flow test did not agree with the test of the object itself.

MR. CLEWS supposed that the measurements were not strictly related to the properties that were desired, and there was something more involved. Mr. Hallsworth said that was so.

Influence of Dry Grinding

MR. J. H. GRAY referred to the point of the finer particles of clay being held in suspension in water, and asked in relation to enamels whether it would make any appreciable difference if the clay was ground very fine in the dry state before being applied to the mill. That was to say, if it was ground finer before being added to the mill than it would be after being added to the mill in the ordinary state; and whether it would be possible to decrease the percentage of clay.

MR. CLEWS replied that it was difficult to give a definite answer. He thought it was somewhat doubtful. In the milling operation with water they were more likely to break down the clay particles to a smaller size than by merely dry grinding. A reduction in size in conjunction with the colloidal properties of clay had a great bearing on the consistency of enamel. For instance, supposing they substituted for ordinary clay a very colloidal type of clay, a much less amount of clay was required to do the job. It might induce other difficulties, but as regards setting enamel up and getting a floating enamel, a small amount of highly-colloidal clay was more effective than the same weight of the ordinary type.

Lump and Powdered Clay

MR. GRAY observed that leading from this aspect he should imagine that there would be another difference between using a lump clay for enamel purposes than a powdered clay. Quite a number of people were using fine powdered clay, but it was more expensive than lump clay, and to that extent its advantage was offset.

MR. CLEWS suggested that they should not carry the practice to extremes. A clay was needed which was sufficiently finely ground to be broken down in the time occupied by the milling. It all depended on the characteristics of the clay used. For example, the time required for water to penetrate into the grain, and each day was different in respect of the time required to slake down properly.

MR. GRIFFITHS indicated that his experience of enamelling clays, where operations were more or less of the same character, was that, whether they added clay in lump or powdered form, it had practically no variation in the effect on the subsequent enamelling.

MR. CLEWS said he quite appreciated that this would be the case with the majority of clays.

MR. GRIFFITHS stated that the water content remained the same whether 2 per cent. of electrolite was added or ¼ per cent.

Quick Test Wanted

MR. HALLSWORTH mentioned that experiments had been made at Stechford on dry weight per square foot, but were not yet finished. If they maintained an equable temperature on the low side and dipped only a few plates to ascertain the weight per square foot, it turned out quite satisfactorily. But in a heated shop, perhaps with varying temperatures, and with a large quantity of dipping to be done, the weight test was too long, inasmuch as they would have to apply the enamel to a large number of plates before the test was finished, and it would be difficult to check. What he wanted was a quick test.

Influence of the Acid Content

MR. GRAY said he understood that the higher the acid content in clay, the less suspension was obtained. He wondered whether the lecturer could afford any help in the selection of clays by suggesting the best type of clay for enamelling which had a low acid content.

MR. CLEWS took it that the natural acid content of clay was referred to. (Mr. Gray assented.) He scarcely thought that this point would arise in connection with floating enamels. They obtained more than that amount of alkali in the decomposition of the frit. Considering the small weight of clay that was used, he thought it was more important to ensure that the clay had a proper distribution of grain size rather than acid content. To see that grain size was very definitely specified was far more important, in his view. In further reply to Mr. Gray, the lecturer recalled the facts he had given in reference to the variability in the distribution of the grain size with different clays, and said the natural acid of the clay was soon altered when it was mixed with all the milling ingredients.

The Water Problem

MR. HALLSWORTH asked, regarding water in different districts, if Mr. Clews could give any idea of the best water to use—soft or hard—and what degree of hardness produced the most satisfactory floating of the clay?

MR. CLEWS did not think they would go far wrong if the water was consistent, and his opinion was that soft or hard water did not much matter. What they had to do was to adapt their working conditions to the type of water used. He did not think they could assert that one water was better than another, speaking generally.

MR. GRIFFITHS mentioned that his firm found that soft water was better than extremely hard well water, which had many times resulted in the accumulation of scum on the melt, and it did not necessarily apply to enamels which they set up.

MR. A. B. ALLEN inquired whether the amount of scum was not so minute as not to affect the enamel. With hard water there was observable some small amount of scum present in the water.

MR. CLEWS believed that results had been reported which were measurable. There was a fair amount of water in the mill, and the amount of soluble salts extracted from the frit was quite small. The two were of comparable magnitude, and he should say that the probable total amount of salts one actually put into the mill would be very small, under 10 grammes at the most.

A MEMBER asked whether 10 grammes of anything except some colour would affect the mill at all?

MR. CLEWS thought so; otherwise how did one explain occurrences which developed merely on leaving the enamel alone?

Water—A Governing Factor

MR. ALLEN suggested that the question of suitable water was bound up with the mobility of the particular enamel in use. Did not the lecturer think that perhaps a number of ground-coat enamels were developed in a particular district because the local type of water was suitable? He thought it was quite true to say that very often an enamel taken from one district to another was found to have a very considerable difference in being worked out.

The CHAIRMAN (Mr. W. Todd) remarked that there were definite cases where enamel from a hard-water district could not be worked where the work was done on soft water.

MR. GRAY stated that, comparing the results obtained from hard water and soft water, the enamel produced from the latter was very much finer when turned out of the mill.

The CHAIRMAN observed that it had been suggested that at Stechford they might use distilled water in order to get the water content suitable. This suggestion was made because they had variations in the water service in their district, sometimes Welsh water and sometimes water from local reservoirs. However, they did not follow this advice, and members present would be wise not to do so either. It was also suggested that they should try a water softener, but they did not embark on this procedure

(*Concluded on page* 126.)

B.A./"Y" ALLOY

YOU NEED NO INTRODUCTION

to "Y" alloy—one of the few good things that came of the Great War.

We should, however, like to introduce you to a thoroughbred version which has brought us many friends.

More particularly, if you are worried with hard inclusions, drossy inclusions, failure to obtain specification values on heat-treatment, B.A./"Y" alloy has set a commercial standard of quality hardly exceeded by its originators in the National Physical Laboratory.

Write for further information. Ref.: DEV.

BA The BRITISH ALUMINIUM Co., Ltd.

Head Office: ADELAIDE HOUSE, KING WILLIAM STREET, LONDON, E.C.4

Telephone: MANSION HOUSE 5561 & 8074 (5 LINES). *Telegrams:* CRYOLITE, BILGATE, LONDON

LONDON WAREHOUSE: 25-29, Pancras Road, N.W.1 | BIRMINGHAM, 4: Lawley Street. | MANCHESTER, 3: 274, Deansgate. | LEEDS, 3: 66, Kirkstall Rd. | NEWCASTLE-ON-TYNE, 1: Milburn House. | GLASGOW, C.2: 113, West Regent St.

and at New York, Toronto, Montreal, Calcutta, Sydney and Johannesburg.

F.T.J. 6.2.36

WARNER Special PIG IRONS

- *Warner C.B.R.*
  and
- *Low Carbon Cylinder*
  (FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- *Low Carbon Malleable*
  (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

Typical Cylinder Pig Iron Specification

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

Typical Malleable Pig Iron Specification

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO. LTD
CARGO FLEET MIDDLESBROUGH

This Week's News in Brief

Trade Talk

CARRON COMPANY'S annual staff dinner, which was to have taken place on February 1, has been postponed in consequence of the death of King George.

A REPEAT ORDER for a new vessel has been placed with Messrs. Alexander Stephen & Sons, Limited, Linthouse, Glasgow, by Messrs. the Clyde Shipping Company, Glasgow.

A LARGE STOCK of bedroom fittings which were to have been installed in the liner "Queen Mary" were destroyed in a fire at the works of Osborne & Company (Dronfield), Limited, brassfounders, Dronfield, Sheffield.

THE TOTAL PRODUCTION of iron and steel at the works of the Tata Iron & Steel Company, Limited, at Jamshedpur during December, 1935, was as follows:—Pig-iron, 79,100 tons; steel ingots, 80,350 tons; finished steel, 60,500 tons.

MESSRS. CAMMELL LAIRD & COMPANY, LIMITED, Birkenhead, have received orders from London owners for two motor tankers. One will have a carrying capacity of 9,500 tons deadweight, the other will have a capacity of 9,200 tons.

A STRIKE BALLOT, the result of which is to be declared almost immediately, has been completed by 1,500 workers in the brass and plumbing trade in Rotherham, Doncaster, Sheffield, Halifax and Cleckheaton. A Council of Action is to be formed, and will operate from Rotherham.

MESSRS. FISHER & LUDLOW, LIMITED, are establishing a new factory in Birmingham, a site of 1½ acres having been acquired in High Street, Bordesley. The cost of the new premises will be £100,000 when equipped with machinery for the production of press tools, jigs and patterns. This new factory will be devoted entirely to the making of new tools, and it will be in production in October.

THE CRITTALL MANUFACTURING COMPANY, LIMITED, manufacturers of metal windows, etc., is making an issue of £850,000 4½ per cent. debenture stock (part of £1,000,000 authorised) at 105 and of 750,000 5½ per cent. first cumulative preference £1 shares at 20s. 6d. The new stock will replace an issue of £500,000 outstanding at 6 per cent. interest. The preference shares will replace existing 6½ per cent. notes.

THE TWENTY-EIGHTH annual general meeting of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on March 11 and 12. The annual dinner, which will be held on the evening of March 11, will be followed by an informal social gathering of members and their friends, instead of the usual dance, which is not being held in view of the national mourning for the late King George V.

MESSRS. BRANDEIS, GOLDSCHMIDT & COMPANY, LIMITED, have issued their annual metal report for 1935. The report is in booklet form and constitutes an exhaustive review of the principal non-ferrous metals throughout the past year. Statistics of prices, consumption, production, etc., are given in detail and the outstanding features of the year, such as the copper-curtailment agreement and the tin-restriction system, are described, together with their effects on the markets.

The Dumbarton Valve Works of Babcock & Wilcox, Limited

(*Concluded from page* 121.)

ment is a battery of electric spot-welding machines.

The finished-valve stores and the shipping departments are common to one building. Here, however, the valves are subject to final inspection before despatch. For this final inspection, the dimensions of the valve type, drilling of flanges, etc., are checked against the order actually received by the Dumbarton works, as distinct from the orders issued by the administrative office of the works.

The offices are located in the north-east corner of the valve works and occupy two floors, and although nothing spectacular can be recorded of them, it will be appreciated that the lay-out, planning and rate-fixing sections perform very important functions in ensuring uninterrupted production.

Personal

MR. DAVID FRAME, chairman of the Hammond Lane Foundry, Limited, Dublin, has been elected a member of the Council of the Irish Free State Federation of Irish Industries.

THE RT. HON. THOMAS JOHNSTON, M.P. for East Stirlingshire, was present at a ceremony in Kirkintilloch when ex-Provost Thomas W. A. Gibson was presented with an illuminated address and writing bureau in recognition of 25 years' service to the community as a councillor. Mr. Gibson is a moulder, and has been in the employment of Messrs. Cameron & Roberton, Limited, for many years.

MAJOR JOHN GREG has been appointed vice-chairman, and Mr. T. N. Ballantyne and Mr. W. H. B. Hatton joint managing directors of the Earl of Dudley's Round Oak Works, Limited, Brierley Hill. Major Greg succeeds the late Sir Mark Webster Jenkinson, and the previous managing director was Major G. D. Burton, who resigned the position on appointment as managing director of the Birmingham Small Arms Company, Limited. Mr. Ballantyne has also been appointed a director of the Earl of Dudley's Baggeridge Colliery, Limited.

THE EMPLOYEES AND STAFF of Messrs. R. B. Tennent, Limited, Whifflet Foundry, Coatbridge, have presented a bureau to Mr. Howard Tennent on the occasion of his coming of age. Mr. Howard Tennent recently returned from Germany, where he had been studying industrial methods on behalf of his father, who is managing director of the firm and treasurer of the Burgh of Coatbridge. Optimistic reference to the future of Whifflet Foundry as a result of the successful working of the Adamite steel-roll-making process was made at the presentation by Mr. James Tennent. The firm has obtained the sole manufacturing rights for the British Empire for the Adamite process.

MR. W. H. AMES has been appointed assistant chief engineer to the Tata Iron & Steel Company, Limited, Jamshedpur, India, and sails for Bombay from Marseilles in the "Ranchi" on February 7. Mr. Ames was formerly chief engineer with the Whitehead Iron & Steel Company, Limited, at Newport and Tredegar, previously holding an appointment with Messrs. Dorman, Long & Company, Limited, Britannia Steelworks, Middlesbrough. He resigns from his present position of chief engineer of the Whitearm Works of Messrs. Rylands Bros., Limited, which latter company is a member of the Lancashire Steel Corporation, Limited, on January 31.

Obituary

MR. HUGH FREW, who for over 40 years was in the employment of Messrs. Smith & Wellstood, Limited, Columbia Foundry, Bonnybridge, died recently. He was in his 74th year and retired from active work about three years ago. Mr. Frew was a prominent personality in the old Volunteers, and one of the veterans who attended the famous "Wet Review."

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"YORCORON." — Yorkshire Copper Works, Limited, Pontefract Road, Stourton, Leeds.

"ANODOLEX."—Birmingham Aluminium Casting (1903) Company, Limited, Birmid Works, Dartmouth Road, Smethwick.

"NORAL."—Aluminium. Northern Aluminium Company, Limited, Bush House, London, W.C.2.

Castings for Electrodeposition

In connection with Mr. B. Caplan's Paper on "Castings for Electrodeposition," published in our issue of January 23, the seventh line in the second last paragraph in column 2 on page 83 should read: "In bright nickel plating the casting emerges from the plating *vat* quite brilliant." The tenth line in the first column of page 84 should read: "The *buffing* was unnecessary."

Company Reports

British Piston Ring Company, Limited.—Interim dividend of 7½ per cent.

C. Akrill & Company, Limited.—Final dividend of 10 per cent., tax free.

Glacier Metal Company, Limited.—The dividend on the 5½ per cent. cumulative preference shares for the period December 12, 1935, to February 29 next will be paid on March 2.

J. & E. Hall, Limited.—Profit, after depreciation, £194,272; brought in, £1,261; directors' fees, £5,000; rents, rates, income-tax provision, etc., £147,088; preference dividend, £7,200; ordinary dividend of 6 per cent., £26,880; carried forward, £9,378.

Contracts Open

Dewsbury, February 15.—Cast-iron pipes and specials, steel tubes, puddled iron tubes, for the Corporation Gas Department. The Gas Engineer, Gasworks, Savile Town, Dewsbury.

Manchester, February 10.— 36-in. and 24-in. cast iron pipes and valves, for the Waterworks Committee. The Haweswater Engineer, Waterworks' Offices, Town Hall, Manchester, 2.

Forthcoming Events

FEBRUARY 12.

The British Cast Iron Research Association:—"The Phase Rule applied to Metals and Alloys." Lecture by Major F. A. Freeth, O.B.E., D.Sc., F.R.S., President of the Association, at the James Watt Memorial Institute, 37a, Great Charles Street, Birmingham, at 2.30 p.m.

Institute of British Foundrymen

FEBRUARY 7.

Birmingham, Coventry and West Midlands Branch:—"Modern Core-Shop Production," Paper by W. H. Smith at the James Watt Memorial Institute, York House, Great Charles Street, Birmingham, at 7.30 p.m.

FEBRUARY 8.

Lincolnshire Section:—"Soundness and Fluidity in Cast Iron." Paper by H. Bunting at the Technical College, Monks Road, Lincoln, at 7 p.m.

Scottish Branch:—"A Plea for Loam Moulding," Paper by R. Liddle at the Royal Technical College, George Street, Glasgow, at 4 p.m.

West Riding of Yorkshire Branch:—"A Preliminary Report on Moulding Costs by the Costing Sub-Committee of the Technical Committee." To be presented by a member of the Sub-Committee at the Technical College, Bradford, at 6.30 p.m.

FEBRUARY 11.

Burnley Section:—"Patternmaking: The Craftsman and his Craft." Paper by H. Stead at the Municipal College, Ormerod Road, Burnley, at 7.15 p.m.

FEBRUARY 12.

Preston Section:—"Materials and Processes used in the Production of Internal-Combustion Engine Castings." Paper by A. L. Key at the Technical College, Corporation Street, Preston, at 7.30 p.m.

FEBRUARY 14.

Wales and Monmouth Branch:—"The Heat-Treatment of Steel Castings." Paper by Prof. W. R. D. Jones, D.Sc., at the Y.M.C.A., Llanelly, at 6.30 p.m.

FEBRUARY 15.

Lancashire Branch:—"Alloy Cast Irons." Paper by P. A. Russell at the Engineers' Club, Albert Square, Manchester, at 4 p.m.

Wales and Monmouth Branch:—Short Paper Competition at the University College, Newport Road, Cardiff, at 6.30 p.m.

FEBRUARY 21.

Sheffield and District Branch:—"Sand and Shot Blasting." Paper by J. H. D. Bradshaw at the Grand Hotel, Sheffield, at 7.30 p.m.

FEBRUARY 22.

East Midlands Branch:—"Non-Ferrous Castings." Paper by A. Logan at Loughborough College, Loughborough, at 6 p.m.

Newcastle-upon-Tyne and District Branch:—"Foundry Products through the Microscope." Paper by E. B. Ellis at Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

The Institute of Vitreous Enamellers

FEBRUARY 6.

Manchester:—"Refractories for Enamelling Muffle Furnaces." Paper by John Walker, A.R.S.M., B.Sc., at the Y.M.C.A., Peter Street, Manchester, at 7.30 p.m.

FEBRUARY 13.

London:—"Town's Gas for Vitreous Enamelling." Paper by W. Dieterichs at British Industries House, Marble Arch, London, W.1.

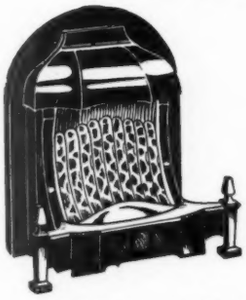
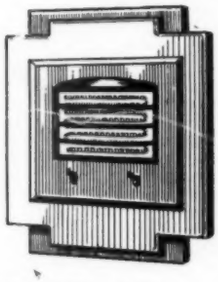
FEBRUARY 20.

Birmingham:—"Heat-Resisting Steels and their Application to Pettits and Petbit Design," Paper by J. G. Holmes and A. Linley at the Chamber of Commerce, New Street, Birmingham, at 7.30 p.m.

HOLWELL IRON

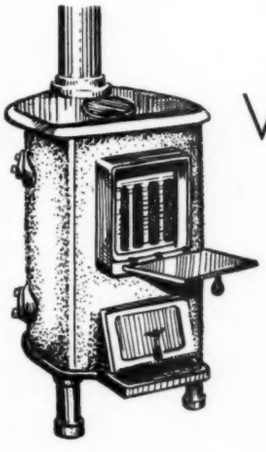
the recognised brand for

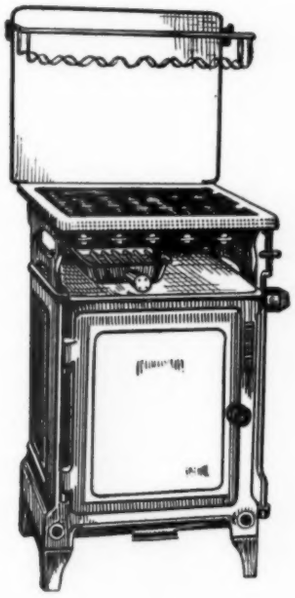
VITREOUS ENAMELLING

THIS  CLEAN MELTING 

FLUID PIG IRON BY VIRTUE

OF A LOW GRAPHITIC CARBON

IS IDEAL FOR  VITREOUS

ENAMELLING 

ANALYSIS

	%
Graph. Carbon	3.16
Comb'd Carbon	0.3
Total Carbon	3.46
Silicon	3.0
Sulphur	0.02
Phos.	1.35-1.55
Mang.	0.44

The Stanton Ironworks Company Limited, Near Nottingham

The Largest Producers of Foundry Pig Iron (for sale) in Great Britain

Raw Material Markets

There has been a rather less volume of business passing in the iron and steel markets recently. This is not due, however, to any slackening of demand on the part of consumers. Forward buying continues to be restricted by the uncertainty of prices. Fuel quotations, which affect iron and steel prices to a considerable extent, are likely to become more settled now that the coalfields dispute is at an end.

Pig-Iron

MIDDLESBROUGH.—Producers of pig-iron are still finding difficulty in satisfying the needs of steelmakers, but, as yet, the volume available has proved sufficient. However, it becomes increasingly obvious that a greater output is necessary. The rising costs of coke will make higher prices inevitable. At the present time very little forward business is being accepted. Deliveries are being kept to schedule, but only with difficulty. Nominal prices are: No. 3 Cleveland G.M.B. 70s. per ton delivered Middlesbrough and Falkirk, 72s. North-East Coast, and 73s. Glasgow, with No. 1 foundry grade 2s. 6d. more and No. 4 foundry and No. 4 forge qualities 1s. per ton less than No. 3.

The demand for East Coast hematite continues to be in excess of the output, and makers are only able to satisfy consumers' requirements by withdrawing from their stocks. However, stocks will not be able to last out very much longer, and so the need for a heavier output is urgent. Prices are expected to be raised in the near future, and consequently forward business is not viewed with favour by producers. Most makers are well sold up to the end of June. The minimum prices are unchanged, No. 1 grade being 71s. per ton delivered Middlesbrough area, 73s. 6d. on the North-East Coast, 74s. in Scotland, 78s. 6d. in Sheffield, and 84s. 6d. in Birmingham.

LANCASHIRE.—New business continues to be at a low ebb in this area. A few transactions have been made involving moderate tonnages, but consumers are keeping out of the market. Machine-tool makers are taking good supplies of pig-iron, and the jobbing foundries are showing welcome signs of an improvement. For delivery to consumers in the Lancashire price zone, offers of Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron are all on the basis of 78s. per ton, with Northamptonshire at 76s. 6d. and Scottish No. 3 at around 83s. 6d. per ton. Prices of hematite are firm, with West Coast material being quoted on the basis of 81s., delivered equal to Manchester, and East Coast quality at from 80s. 6d. to 81s. per ton.

MIDLANDS.—Satisfactory conditions continue to prevail with the light-castings makers and the engineering works. Ironfounders are working to the limits of capacity. Producers are unwilling to enter into forward business owing to the uncertainty of prices. The controlled prices for common foundry irons are 72s. 6d. for Northants No. 3 and 75s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, including delivery to Birmingham and Black Country stations, and subject to a small sliding-scale rebate for large consumers. Special irons, which are not controlled, are still quoted at firm levels as follow:—Medium-phosphorus iron is on offer at from 77s. 6d. to 87s. 6d., low-phosphorus 90s. to 97s. 6d., and refined pig-iron from £6 5s. to £7 15s. per ton, delivered this area. Hematite makers are reluctant to book orders for forward delivery. Prices are nominal, and include delivery to Birmingham and Black Country stations. West Coast mixed numbers are quoted at £4 4s. 6d. and East Coast No. 3 at £4 3s. 6d., with Welsh mixed numbers at £4 3s., plus 1s. 6d. extra for delivery into works in 10-ton lots.

SCOTLAND.—Deliveries of pig-iron continue to be on a good scale in this area, and business is very satisfactory. Prices are unchanged, the official minimum of 74s. f.o.t. furnaces for No. 3 foundry still being quoted, with 2s. 6d. per ton extra for No. 1. Prices for No. 3 Cleveland iron are also unchanged at 70s. f.o.t. Falkirk and 73s. f.o.t. Glasgow, with other English foundry irons quoted at 1s. 3d. per ton below the foregoing figures. Local steelworks are very well employed.

Coke

The settlement of the coal dispute has made conditions very much easier in the coke market. Prices, however, remain unchanged. For delivery in Birmingham and district best Durham coke is on offer at from 41s. 6d. to 43s., with other grades down to 39s. 6d., while Welsh coke is on offer at from 37s. to 50s. per ton.

Steel

Busy conditions rule in the steel market, and although trading in one or two departments may have slowed down somewhat, this was because of the reluctance displayed by producers towards entering into fresh commitments, says the official report of the London Iron and Steel Exchange. The outlook so far as prices are concerned seems uncertain, and until the situation is clearer in this respect there is a tendency to approach forward business with caution. The situation in the semi-finished steel department has not materially altered. The producing works are operating at capacity, but their output is not sufficient to meet the market requirements. Consumers, however, are experiencing relief from the increased imports of Continental semi-finished steel, a considerable tonnage of which has arrived recently. New business in finished steel which had been restrained pending a settlement of the coal dispute has become more active. A large volume of inquiry is in circulation, and although most of this is for the home market, oversea buyers have recently shown more interest. Nearly all works are operating at capacity.

Scrap

In spite of the sharp advance in prices of iron and steel scrap on the Cleveland market, supplies still remain inadequate. All supplies are disposed of immediately they enter the market. Prices are unchanged at the previous firm levels. The minimum delivered price for good heavy melting steel is 57s. 6d. per ton, while special quality has fetched up to 60s. Good machinery metal remains at 65s., but supplies are very scarce. Firm conditions prevail on the South Wales market, the demand being far in excess of the supply. Business is confined to small parcels for prompt delivery. Good, heavy, mild-steel scrap, in furnace sizes, has a quiet demand, but is very firm, at 65s. to 67s. 6d. Mixed wrought-iron and steel scrap for basic furnaces is in active request at 60s. to 62s. 6d. Heavy cast iron, in large pieces and furnace sizes, has an increased following at 57s. 6d. to 60s. Good cast-iron machinery scrap in sizes suitable for foundries is quiet at 62s. 6d. to 65s. Conditions in the Midlands remain without much change. Suppliers continue to press for higher quotations, while consumers are doing their best to keep prices at a reasonable level. Heavy steel, in furnace sizes, is at 52s. 6d. to 55s. Short heavy steel scrap, as used in the foundries, is at 60s. to 62s. 6d., delivered works. Similar conditions as last week still prevail on the Scottish market. Prices are firm. Heavy mild-steel melting scrap, in furnace sizes, is at 52s. 6d. per ton, with heavy basic, or heavy iron and steel scrap mixed, 5s. per ton less. Heavy machinery cast-iron scrap is higher around 67s. 6d. to 70s. per ton, delivered f.o.t. consumers' works.

Metals

Copper.—Rather featureless conditions have prevailed in this market during the past week. Prices have fallen slightly. Consumption is on a satisfactory level, but the market is in need of a stimulus. New business in the United States is on a low level, and conditions generally are dull; consumption, however, is maintained, and deliveries of domestic copper in the United States during the past month are reported to have exceeded the apparent consumption by 15,000 short tons.

Daily market prices:—

Cash.—Thursday, £34 16s. 3d. to £34 18s. 9d.; Friday, £34 13s. 9d. to £34 15s.; Monday, £34 10s. to £34 11s. 3d.; Tuesday, £34 8s. 9d. to £34 10s.; Wednesday, £34 13s. 9d. to £34 15s.

Three Months.—Thursday, £35 6s. 3d. to £35 7s. 6d.; Friday, £35 1s. 3d. to £35 2s. 6d.; Monday, £34 17s. 6d. to £34 18s. 9d.; Tuesday, £34 16s. 3d. to £34 17s. 6d.; Wednesday, £35 1s. 3d. to £35 2s. 6d.

Tin.—Slack conditions have been apparent in this market, and prices have fallen again. Trade demand remains quiet in this country, as is also the case on the Continent and in the United States. Political conditions have an adverse influence on Continental business. In the United States ordinary users are not entering the open market, but some enthusiasm has been caused by a Navy order for about 240 tons of tin. A sharp rise in tin stocks is indicated by the end of January statistics compiled by Mr. W. H. Gartsen (Henry Rogers Son & Company). The total visible supplies at the end of January were 12,157 tons, and show a reduction of 148 tons compared with the position at the end of December last. The carry-over in the Straits Settlements increased by 1,242 tons to 3,265 tons, and at Arnhem (Holland) by 117 tons to 630 tons. Total stocks were thus 2,211 tons higher at 16,052. The expansion in stocks is accounted for by the raising of quotas by the International Tin Committee.

Metal Exchange quotations were as follow:—

Cash.—Thursday, £206 to £206 10s.; Friday, £208 to £209; Monday, £204 10s. to £204 15s.; Tuesday, £203 15s. to £204 5s.; Wednesday, £203 10s. to £204.

Three Months.—Thursday, £198 to £198 5s.; Friday, £198 5s. to £198 10s.; Monday, £197 5s. to £197 10s.; Tuesday, £197 12s. 6d. to £197 15s.; Wednesday, £197 17s. 6d. to £198.

Spelter.—A less firm undertone exists in this market. Present buying is on a low scale. Consumption is reported to be satisfactory. The market is also quiet on the Continent, where the undertone remains steady.

Official quotations were as follow:—

Ordinary.—Thursday, £15 2s. 6d.; Friday, £15 1s. 3d.; Monday, £14 15s.; Tuesday, £14 8s. 9d.; Wednesday, £14 8s. 9d.

Lead.—This market has had a quieter tone during the past week. Buying is on a fairly good scale. The United States also reports improved buying, and the market is very sound. The American Bureau of Metal Statistics estimates world production of lead in 1935 as 1,569,670 short tons, an increase of slightly over 5 per cent. on the 1934 total of 1,494,743 tons.

Day-to day quotations:—

Soft Foreign (Prompt).—Thursday, £16 5s.; Friday, £15 18s. 9d.; Monday, £15 13s. 9d.; Tuesday, £15 10s.; Wednesday, £15 10s.

GANISTER

Purchase your supplies from actual Producers with over 50 years' reputation

Scientifically treated, specially ground Ganister for Cupolas, Iron & Steel Works, &c.

SPECIAL LADLE GANISTER

TRIAL BAGS FREE
Quotations on application

The ASTBURY SILICA CO.
CONGLETON, Cheshire
Est. 50 Years

IDAHO PINE
YELLOW PINE

PRIME & PATTERN GRADES
½" to 3" thick
Width up to 24" wide
All free of centre heart and shake

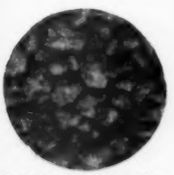
CHETHAM TIMBER
Co., Ltd.,
70, FINSBURY PAVEMENT,
LONDON, E.C.2
Metropolitan 7418

MOULDING SANDS—from our own quarries—milled in our own works

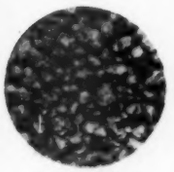
—to your specification

STEEL Moulding Sands, Iron and Non-ferrous Moulding Sands of every type—there are over fifty different grades from which to choose—are produced by us at centres situated throughout England and Scotland. With these facilities, the founder is able to gain considerable advantage by having sand delivered at low Railway rates. You cannot do better than specify a G.R. Sand whether you require it Coarse, Medium or Fine in grain and either well or weakly bonded. The Micro-photographs reproduced on the right—magnified eight times—show the remarkable grain structure of just six of the Moulding Sands we supply. Information regarding the most suitable sand for your particular need and full technical details will be given without obligation.

Please write for further particulars

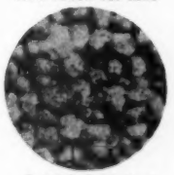


Yorkshire Steel Moulding Sand

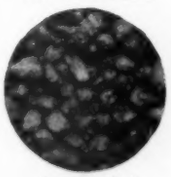


Zenith Red Sand

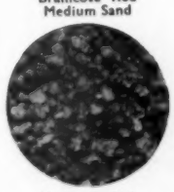
York Yellow 102 Sand



Scottish Rock Sand



Bramcote Red Medium Sand



Bramcote Red Superfine Sand

GENERAL REFRACTORIES LIMITED

Telephone: *Sheffield* 31113 (6 *lines*).

Telegrams: "*Genefax, Sheffield.*"

Genefax House, Sheffield.

LONDON OFFICE: Russell House, Adelphi, W.C.2. Telephone: Temple Bar 7361.

SOUTH WALES OFFICE: 11, Wind Street, Swansea. Telephone: 3680.

SCOTTISH OFFICE: 156, St. Vincent Street, Glasgow. Telephone: 5250.

RAW MATERIALS—PRICE LIST

(Wednesday, February 5, 1936)

COPPER

	£ s. d.
Standard cash	34 13 9
Three months	35 1 3
Electrolytic	38 17 6
Tough	37 5 0
Best selected	37 15 0
Sheets	66 0 0
India	48 5 0
Wire bars	38 17 6
Ingot bars	38 17 6
H.C. wire rods	42 7 6
Off. av. cash, Jan.	34 14 10⅞
Do., 3 mths., Jan.	35 2 10⅝
Do., Sttlmnt., Jan.	34 15 1½
Do., Electro, Jan.	39 0 3¾
Do., B.S., Jan.	38 10 3½
Do., wire bars, Jan.	39 4 10½
Solid drawn tubes	10½d.
Brazed tubes	10½d.
Wire	6¼d.

BRASS

Solid drawn tubes	9½d.
Brazed tubes	11¾d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£ s. d.
Standard cash	203 10 0
Three months	197 17 6
English	203 15 0
Bars	205 0 0
Straits	205 0 0
Australian	203 10 0
Eastern	204 7 6
Banca	204 10 0
Off. av. cash, Jan.	209 18 9
Do., 3 mths., Jan.	201 9 0¾
Do., Sttlmt., Jan.	209 19 0

SPELTER

	£ s. d.
Ordinary	14 8 9
Remelted	13 0 0
Hard	12 0 0
Electro 99.9	16 12 6
English	15 7 6
India	13 0 0
Zinc dust	19 10 0
Zinc ashes	4 5 0
Off. aver., Jan.	14 12 0¾
Aver. spot, Jan.	14 9 9

LEAD

	£ s. d.
Soft foreign ppt.	15 10 0
Empire (nom.)	16 5 0
English	17 10 0
Off. average, Jan.	15 8 10⅞
Average spot, Jan.	15 7 11¼

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	22 15 0
Do., V.M. ex-whse.	23 15 0
Rods	27 5 0

ANTIMONY

	£ s. d.
English	72 0 0 to 73 0 0
Chinese, ex-whse.	63 0 0
Crude, c.i.f.	32 0 0

QUICKSILVER

	£ s. d.
Quicksilver	12 2 6 to 12 8 6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£18 0 0 to £20 0 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	33 0 0
4/6% car.	21 15 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	33 10 0
Max. 1% car.	36 5 0
Max. 0.70% car.	37 5 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to 11 5 0
76/80% packed	£11 15 0 to 12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	3 5 0	to 3 7 6
Mixed iron and steel	3 0 0	to 3 2 6
Heavy cast iron	2 17 6	to 3 0 0
Good machinery	3 2 6	to 3 5 0
Cleveland—		
Heavy steel	2 17 6	to 3 0 0
Steel turnings		2 0 0
Heavy cast iron		3 0 0
Heavy machinery		3 5 0
Midlands—		
Light cast-iron scrap	2 10 0	to 2 12 6
Heavy wrought iron	3 5 0	to 3 10 0
Steel turnings	2 0 0	to 2 2 6
Scotland—		
Heavy steel		2 12 6
Ordinary cast iron		3 2 6
Engineers' turnings		2 2 6
Cast-iron borings	1 17 6	to 2 0 0
Wrot-iron piling		3 8 6
Heavy machinery	3 5 0	to 3 6 6

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	28 10 0
Brass	19 0 0
Lead (less usual draft)	14 10 0
Tea lead	10 10 0
Zinc	8 10 0
New aluminium cuttings	74 0 0
Braziery copper	26 0 0
Gunmetal	27 0 0
Hollow pewter	150 0 0
Shaped black pewter	115 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	72/6
,, No. 3	70/-
,, at Falkirk	70/-
,, at Glasgow	73/-
,, No. 4	69/-
Forge No. 4	69/-
Hematite No. 1	71/-
Hematite M/Nos.	70/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	74/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	71/-
,, No. 3 fdry.	75/-
Northants forge	68/6
,, fdry. No. 3	72/6
,, fdry. No. 1	75/6
Derbyshire forge	71/-
,, fdry. No. 3	75/-
,, fdry. No. 1	78/-
Scotland—	
Foundry, No. 1, f.o.t.	76/6
,, No. 3, f.o.t.	74/-
Hem. M/Nos. d/d	73/6
Sheffield (d/d district)—	
Derby forge	68/6
,, fdry. No. 3	72/6
Lincs forge	68/6
,, fdry. No. 3	72/6
W.C. hematite	86/-
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	78/-
Staffs fdry. No. 3	78/-
Northants fdry. No. 3	76/6
Cleveland fdry. No. 3	78/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/6
Clyde, No. 3	83/6
Monkland, No. 3	83/6
Summerlee, No. 3	83/6
Eglinton, No. 3	83/6
Gartsherrie, No. 3	83/6
Shotts, No. 3	83/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 12 6	to 9 15 0
Nut and bolt iron	7 17 6	to 8 7 6
Hoops	10 10 0	and up.
Marked bars (Staffs) f.o.t.	12 0 0	
Gas strip	10 10 0	and up.
Bolts and nuts, ¾ in. × 4 in.	15 5 0	and up.
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	9 5 0	to 9 7 6
Chequer plts.	10 7 6	
Angles	8 7 6	
Tees	9 7 6	
Joists	8 15 0	
Rounds and squares, 3 in. to 5½ in.	9 7 6	
Rounds under 3 in. to ⅝ in. (Untested)	8 12 0	
Flats—8 in. wide and over	8 12 6	
,, under 8 in. and over 5 in.	8 17 6	
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 5 0	to 12 10 0
Hoops (Staffs)	9 7 0	
Black sheets, 24g. (4-t. lots)	11 10 0	
Galv. cor. shts. (,,)	13 10 0	
Galv. flat shts. (,,)	14 0 0	
Galv. fencing wire, 8g. plain	15 10 0	
Billets, soft	5 10 0	and up.
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 10 0	to 5 15 0
Tin bars	5 10 0	to 5 15 0

PHOSPHOR BRONZE

	Per lb. basis
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	21.31
No. 2 foundry, Valley	19.50
No. 2 foundry, Birm.	15.50
Basic, Valley	19.00
Malleable, Valley	19.50
Grey forge, Valley	19.00
Ferro-mang. 80%, seaboard	75.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	40.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	19/- to 20/-
Durham foundry	21/6
,, furnace	19/6
Scotland, foundry	30/-
,, furnace	25/- to 26/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14	per box	18/9 to 19/-
,,	28×20	,,	37/6 to 38/-
,,	20×10	,,	27/- to 28/-
,,	18¾×14	,,	19/-
C.W.	20×14	,,	16/-
,,	28×20	,,	34/-
,,	20×10	,,	23/3
,,	18¾×14	,,	16/3

SWEDISH CHARCOAL IRON & STEEL

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars-hammered, basis	£16 0 0	to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0	to £16 0 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£30 0 0	to £31 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, st'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
Jan. 30 ..	34	16	3	dec.	1/3
„ 31 ..	34	13	9	„	2/6
Feb. 3 ..	34	10	0	„	3/9
„ 4 ..	34	8	9	„	1/3
„ 5 ..	34	13	9	inc.	5/-

Electrolytic Copper

	£	s.	d.		
Jan. 30 ..	39	0	0	No	change
„ 31 ..	38	15	0	dec.	5/-
Feb. 3 ..	38	10	0	„	5/-
„ 4 ..	38	7	6	„	2/6
„ 5 ..	38	17	6	inc.	10/-

Standard Tin (cash)

	£	s.	d.		
Jan. 30 ..	206	0	0	dec.	30/-
„ 31 ..	208	0	0	inc.	40/-
Feb. 3 ..	204	10	0	dec.	70/-
„ 4 ..	203	15	0	„	15/-
„ 5 ..	203	10	0	„	5/-

Tin (English ingots)

	£	s.	d.		
Jan. 30 ..	206	5	0	dec.	30/-
„ 31 ..	208	10	0	inc.	45/-
Feb. 3 ..	204	10	0	dec.	80/-
„ 4 ..	204	0	0	„	10/-
„ 5 ..	203	15	0	„	5/-

Spelter (ordinary)

	£	s.	d.		
Jan. 30 ..	15	2	6	dec.	1/3
„ 31 ..	15	1	3	„	1/3
Feb. 3 ..	14	15	0	„	6/3
„ 4 ..	14	8	9	„	6/3
„ 5 ..	14	8	9	No	change

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
Jan. 30 ..	17	3	9	dec.	1/3
„ 31 ..	17	1	3	„	2/6
Feb. 3 ..	16	18	9	„	2/6
„ 4 ..	16	12	6	„	6/3
„ 5 ..	16	12	6	No	change

Zinc Sheets (English)

	£	s.	d.		
Jan. 30 ..	23	7	6	No	change
„ 31 ..	23	5	0	dec.	2/6
Feb. 3 ..	23	0	0	„	5/-
„ 4 ..	22	15	0	„	5/-
„ 5 ..	22	15	0	No	change

Lead (English)

	£	s.	d.		
Jan. 30 ..	18	5	0	inc.	5/-
„ 31 ..	18	0	0	dec.	5/-
Feb. 3 ..	17	15	0	„	5/-
„ 4 ..	17	10	0	„	5/-
„ 5 ..	17	10	0	No	change

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1898	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 5
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	12 11 5½	
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 6½
1931	9 15 0	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 9	9 5 6	9 9 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 17 10
1933	8 10 0	8 10 0	8 10 0	8 8 9	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 6 0	8 7 6	8 6 10½
1934	8 8 1½	8 10 7½	8 16 6	8 17 6	8 6 3	8 6 3	8 5 7½	8 5 0	8 5 0	8 5 0	9 6 3	9 6 3	8 11 6½
1935	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3	9 6 3

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

B.SC., age 25, practical experience of ferrous, metallurgy and coal distillation, 3 years' exceptional commercial experience as assistant to managing director of a commercial syndicate, including office organisation, law of contract, sales, etc., desires change. —Box 574, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

HEAD Foundry Foreman desires change. Wide experience in general engineering castings and mechanised and mass-production plant. Capable of laying out foundry for quick and economical production, fix rates, produce from and quote to drawings. Strict disciplinarian. Able take control entire foundry without supervision.—Write Box 568, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

STEELFOUNDRY Foreman seeks progressive position. 37 years' practical experience in modern foundry methods; light and medium castings.—Box 560, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EXPERIENCED Foreman Moulder for steelfoundry producing 10 tons small and medium castings per week. Experience of converter process essential.—Box 570, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

STEELFOUNDRY Foreman required for a foundry in the Home Counties. Energetic, forceful, good disciplinarian. State age, wages, and experience.—Box 578, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TECHNICAL Assistant to Foundry Manager, to control cupolas and sands and check-up on day-to-day technical problems. Good prospects for keen and energetic young man. Write with full particulars of training, experience, age, and salary required, to Box 572, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED for malleable foundry in Midlands, a young man of good technical education to qualify as Assistant Works Manager in a good-sized works. Must have black-heart experience.—Box 576, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED. — First-class Foreman for vitreous-enamel plant, cast and sheet iron. Must be familiar with jobbing work and able to control large staff. High speed quality production essential.—Write Box 580, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOREMAN Brassmoulder requires position. Wide experience general and repetition, including machine moulding and aluminium practice. (272)

FOUNDRY Foreman requires position with progressive firm. Varied experience, including several years as foreman with manufacturers' woodworking machinery and similar plant. (273)

MACHINERY

GOOD second-hand Cupola Hoist wanted; half-ton capacity; height of platform approximately 13 ft. Must be in sound working condition.—VOWLES BROTHERS, LIMITED, West Bromwich.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

FOR SALE.—Three "Ajax" No. 9 Turnover Moulding Machines and one "Ajax" Stripping-Plate Moulding Machine with vibrator, complete with all accessories. Can be seen under working conditions. Price £50 each. —THOMAS BROADBENT & SONS, LIMITED, Huddersfield.

Tilghman Sandblast Barrel Plants; barrel sizes—60 in. x 40 in.; 36 in. x 20 in.; 20 in. x 30 in.

Tilghman Sandblast Cabinet Plants; 4 ft. 6 in. and 3 ft. 6 in. square (one for high pressure 70 lbs. per sq. in.); also small Cabinet 30 in. dia.

All complete with Air Compressors, etc.

Pneulec Royer Sand Thrower, size No. 1.

Six Osborne Pneumatic Jolt Press Moulding Machines, size 75J.

Three Mumford Yoke Headpress Pneumatic Moulding Machines.

Two Herbert Whizzer Sand Disintegrators.

Two Brealey Type ditto.

Heavy Double-ended Grinding Machines by Rowlands, Luke & Spencer, etc.

Hand Moulding Machines by Adaptable Darling & Sellars, Pridmore, Samuelson, etc.

500 Electric Motors, Dynamos, Rotary Converters, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.

'Phone: Broadwell 1359.

THOS. W. WARD LTD.

10-ton Dewhurst End-tipping SLAG LADLE; length over buffers, 11′ 6″; wheel centres, 6′ 9″; height of ladle, 7′ 4″.

Inclinable TUMBLING BARREL (Canning); 22″ dia. barrel x 18″ deep; 50 r.p.m., 12″ dia. F. & L. pulleys; 3″ face.

Three LANCS BOILERS; 30′ x 8′; 140 lbs. w.p.

Write for "Albion" Catalogue.

Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MISCELLANEOUS

SHOT supplies wanted for shop-blasting iron castings.—Write EDWARD MATTHEWS, LTD., Bilston Staffs.

FOUNDRY Material Purchases. Advertiser with many years' experience in buying and contracting acts as consultant on general foundry equipment, plant and sundry materials. Write without obligation for further particulars to Box 582, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FLUIDITY TESTS as described in THE FOUNDRY TRADE JOURNAL, February 1, 1934. Patterns of the above in aluminium can be supplied for 35s. per set. Post free. We can also supply Patterns for all branches of the engineering trade, in hard or soft woods. Send us your inquiries. — FURMSTON & LAWLOR, Patternmakers, Letchworth, Herts.

MISCELLANEOUS—*Continued*

WANTED by ironfoundry doing medium and heavy castings, a variety of second-hand Moulding Boxes. Write giving full particulars to Box 584, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

SAND PLANT

Herbert Whizzer, large size. **£48.**
Brealey Disintegrator, NEW. **£26.**
Pneumatic Riddles, Jackman type. **£9 each.**

SANDBLAST PLANT

BARREL PLANT by Tilghman, *as new*, 60″×40″. Price **£240.**

NEW 8′×8′ ROOM PLANT, complete. Price **£230.**

CAST IRON ROOM PLANT, 12′×9′, complete with 400 cu. ft. motor-driven compressor for A.C. current, in new condition. Cheap.

Several small complete barrel plants in stock.

Genuine Evans 10-ton Crane Ladle. Price **£35.**

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

SELECT YOUR MACHINE FROM THE LARGEST STOCK OF HIGH-CLASS SECONDHAND MOULDING MACHINES IN THE WORLD

Practical Advice Free

THE COLEMAN FOUNDRY EQUIPMENT Co. LTD.
156, STRAND, LONDON, W.C.2.

WHEN THINKING OF SANDBLAST THINK OF RICHARDSON'S
Established 1887.

We Supply Re-Conditioned & New
SAND BLAST PLANTS AND AIR COMPRESSORS.
Tilghman's, Room, Barrel, Chamber, Rotary Table, Dust Arrester, and Continuous Feed Barrel Plants.

Phone: MIDLAND 2281.
Grams: "SANDBLAST, B'HAM."
R. J. RICHARDSON & SONS, Ltd.,
Commercial Street, Birmingham.